DOCUMENT RESUME

ED 329 103 FL 018 833

TITLE	English Skills for Life Sciences: Problem Solving in Biology. Tutor Version and Student Version.
INSTITUTION	Arlington County Public Schools, Va.; California Univ., Los Angeles. Center for Language Education and Research.; Center for Applied Linguistics, Washington, D.C.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	90
NOTE	475p.; For related documents, see FL 018 829 and FL 018 831.
PUB TYPE	Guides - Classroom Use - Instructional Materials (For Learner) (051) -- Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC19 Plus Postage.
DESCRIPTORS	*Biology; Concept Formation; Cooperative Learning; *English (Second Language); *English for Science and Technology; Introductory Courses; *Limited English Speaking; Problem Solving; *Science Instruction; Secondary Education; Second Language Instruction; Vocabulary Development; Workbooks
IDENTIFIERS	*Simplification (Language)

ABSTRACT

This manual is part of a series of materials designed to reinforce essential concepts in physical science through interactive, language-sensitive, problem-solving exercises emphasizing cooperative learning. The materials are intended for limited-English-proficient (LEP) students in beginning physical science classes. The materials are for teams of two students, the student and the tutor, with a separate workbook for each. Questions appear in the student workbook, prompts and answers in the otherwise identical tutor workbook. This combined document consists of the "Tutor Version" followed by the "Student Version." The volumes on problem-solving in biology address a variety of topics, including scientific method, affixes, measurement, classification, the cell, bacteria, the digestive system, nutrition, the circulatory system, the respiratory system, the skeletal and muscular system, the nervous system, the endocrine system, reproduction, integrated systems, genetics, and ecology. For each topic, the unit offers a brief introduction and a series of exercises. An index to specific terms used in the workbook is included. (MSE)

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ED329103

ENGLISH SKILLS FOR LIFE SCIENCES:
PROBLEM SOLVING IN BIOLOGY

Center for Language Education and Research

Center for Applied Linguistics

Arlington County Public Schools

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ENGLISH SKILLS FOR LIFE SCIENCES:

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TUTOR VERSION

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TEACHER'S GUIDELINES

These materials are designed to reinforce essential concepts in physical science through the use of interactive, language-sensitive problem solving exercises. The targeted students are limited English proficient (LEP) students in beginning physical science classes.

It is intuitively obvious that students have difficulty learning content information unless that content is cognitively accessible to them; that is, unless it is presented to them in a comprehensible way. Good teachers have always done this; they assess students' knowledge and start their explanations from the students' understanding. But for LEP students, making the content cognitively accessible includes not only building content explanations from their base knowledge but also presenting the content in comprehensible language forms. It is only when accessible content is presented through accessible language that either is successfully mastered.

Language-sensitive instruction does not "dumb down" the curriculum; it merely makes the existing content material cognitively accessible to the student. This is accomplished through modifications such as deciding which specialized vocabulary items are truly necessary at the beginning levels and presenting them at a manageable rate; recognizing that some everyday words (serrated, slimy) are unfamiliar to LEP students and must also be treated as new vocabulary; making certain that the language used makes explicit connections between related facts and their unifying concepts; and avoiding the highly complex sentence structures so often found in scientific and technical writing. And if the material is cognitively accessible, students are not limited to rote memorization of poorly grasped facts but can bring higher cognitive processes to bear on their attempts to assimilate the information.

The ability to solve problems—that is, the ability to apply learned information to new and different situations—has long been recognized as a goal of education. There is, however, a growing body of research which suggests that problem-solving is the very process through which effective learning is accomplished. Problem-solving is perhaps particularly important in the sciences, where "facts" change so rapidly due to leaps in technology that memorization is becoming all but obsolete as a scientific tool.

Thus, problem solving is moving from product to process. One of the goals of the educational system, then, should surely be to help students develop the necessary problem-solving skills. Many different paradigms have been developed to demonstrate problem-solving techniques, but most rely at least upon identifying the problem, isolating the relevant facts, and setting these facts in the proper relationship to each other in order to determine a solution.

Cooperative learning and problem-solving are natural partners; the problem-solving tasks of identifying, isolating, and relating facts readily lend themselves to this kind of mutual effort, with each member contributing his own understanding to the problem at hand. The point of cooperative learning is that students are able to help each other learn; they can share ideas, model appropriate strategies, and otherwise move each other toward mastery of the specified material. Students are compelled to clarify their thoughts about the subject matter because they must convey their ideas to each other and must reconcile conflicting impressions as they work toward a solution.

Cooperative learning is an equally effective partner to language learning. Language is learned most effectively when it is used for real communication, as the vehicle for thoughts rather than as an end in itself. Cooperative learning requires students to carry out involved verbal tasks such as explaining, clarifying, and negotiating, where the content of the message is the central concern.

Thus the educational strategies underlying these materials serve to complement each other in ways that elicit the abilities of students who might otherwise be unable to express themselves. Language-sensitive instruction provides the students with appropriate comprehensible information; problem-solving tasks guide them toward successful assimilation of that knowledge; and cooperative learning compels them to articulate their understanding of the material as they work together toward mastery of the content.

ORGANIZATION OF MATERIALS

The materials are designed to be used by teams of two students, the Student and the Tutor. A separate workbook is provided for each member of the team. The question for each task appears in the Student workbook, with accompanying prompts and answers in the Partner workbook.

ORGANIZING THE STUDENT/TUTOR TEAMS

If the class consists of both native and non-native speakers of English, use native/non-native teams. This will provide the best language model for the non-native students. If the class consists only of non-native speakers, try to team students of different language backgrounds to encourage their use of English rather than their native language.

CONTENT

Unit 1 focuses on solving word problems using 5 common formulas in physical science. There are five sections, each dealing with a different formula.

Each section begins with questions about the formula itself. It is important to reinforce the meaning of the symbols in the formula and their relationship. These questions discuss the formula in qualitative terms.

The remainder of each section is devoted to word problems which require the target formula. The workbook takes a step approach to problem-solving. Rather than emphasizing the numerical answer, these questions guide the student, step by step, through the *process* of solving a problem. For each word problem, the student must answer questions that measure comprehension of the content of the question, ability to translate words to symbols, and finally, the ability to correctly put the numbers into the equation.

Unit 2 focuses on physical science terminology, symbolism, and graphic representations. A glossary of physical science terms and notations is given. The glossary is followed by exercises which test comprehension of vocabulary. Students are encouraged to consult the glossary for help. This not only reinforces the terms, but provides practice in manipulating the language.

Interpreting and drawing graphs is often a difficult task for students. Therefore, a section describing the uses of various graph types has been included. Students are asked to interpret graphs. Eventually they are given data and required to choose the appropriate type of graph and to draw the graph.

The final section covers chemistry, including safety in the laboratory, equipment, experimental design, symbolic notation, and basic molecular concepts. Since the number of elements and compounds is so great, there will doubtless be some substances emphasized here that are not covered by all teachers. It may be necessary to instruct students to skip compounds that have not been covered in class.

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SCIENCE METHODS

SCIENCE METHODS

How does "science" happen? A scientific advance always begins with an ***observation***. Someone notices that gases expand when they are heated. You notice that when you touch something hot, your hand pulls away from the heat source even before you realize it is hot.

How do these things happen? Using knowledge of the systems or processes involved, the scientist makes guesses about the cause. A guess is called a ***hypothesis***. Some of the guesses may be unusual or unbelievable. At this stage it is best to think creatively and freely.

Next, the scientist chooses the hypothesis that seems most likely to be true. The scientist conducts ***experiments*** to test the hypothesis. The results of the experiment may lead the scientist to drop a hypothesis. Or the results may support the hypothesis. If enough support for the hypothesis is found, the hypothesis is called a ***theory***. Many experiments must confirm the hypothesis before it becomes a theory. A theory explains an observation in terms of things that are already known. A theory also ***predicts*** what will happen under given circumstances. A scientific theory must always be able to make predictions.

Theories are not absolute. They must be modified as new information is obtained. A theory that is accepted may later be rejected because of new information.

A scientific ***law*** is a statement about an observation. Laws describe things that have been observed always to be true. For example, it is a law that when you increase the temperature of a gas, either its volume or the pressure it exerts will increase. There is nothing about *why* included in the law.

SOLVING SCIENCE PROBLEMS

When you are trying to solve a science problem it is helpful to follow certain steps. 1) First, completely define the situation, making a list of everything you know (measurements, things involved, etc.). 2) List the steps in the process being studied. 3) List all the systems, organs, or structures that might be involved in the process. 4) Next, think of all the explanations you can. Be creative — don't rule out any ideas at this stage. Just write down all your ideas. 5) Later, check your ideas and decide if you think they are possible. Choose the idea that seems the most likely. 6) Go back to your list of what you observed. Try to explain what is happening using the idea you came up with.

EXPERIMENTING

When you conduct a scientific experiment, there are certain guidelines you should follow. 1) First, state the hypothesis you wish to test. For example, *"Red light makes plants grow less than normal light."* 2) Second, make a prediction about what will happen in the experiment if your hypothesis is true. Predictions are usually stated with "If..., then...". Here the prediction would be *"If I grow some plants in red light and some in normal light, then the plants grown in red light will grow less."* Third, design and set up the experiment. The ***experimental group*** is the group of things you are using in the experiment. For example, if you are experimenting to see how red light affects plants, the plants you shine red light on are the experimental group. It is important to always have a second group. The second group is the ***control group***. The control group does not receive experimental treatment. In the example above, the control group would be plants that are grown in normal light. You can compare the experimental group to the control group. During the experiment, you observe to see what happens. This is called ***data collection***. The ***result*** of the experiment is the final outcome. For example, *the plants in red light grew less than the normal plants* is a result. Finally, after the experiment, you look at the results to see if they match your prediction. A ***conclusion*** is what you believe after examining the results. *Red light makes plants grow less* is a conclusion.

MATCHING

Match the experimental terms on the left with the examples on the right.

- hypothesis
- control group
- experimental group
- data collection
- results
- conclusion

- 3 of the plants watered with salt water died. The other two only grew 1.2 cm. None of the plants watered with tap water died. All these plants grew at least 2.7 cm.
- Salt water is probably worse for plants than regular tap water.
- Every day I measure all the plants. Also, I check to see whether any of them have died.
- Plants watered with regular tap water
- Salt water is worse for plants than regular tap water. Plants that are watered with salt water have a better chance of dying and don't grow as much as plants watered with tap water.
- Plants watered with salt water

ARISTOTLE

Aristotle was a great Greek philosopher who lived around 350 B.C. To learn about the horse's anatomy, Aristotle dissected a dead horse. When he cut open the heart, he found a bone-like structure in one chamber. In writing his conclusions from the dissection, Aristotle stated that all horses have bones in their heart. For hundreds of years, textbooks stated that horses have bones in their hearts. Today, scientists do not believe that horses have bones in their heart.

A) How did Aristotle make this mistake?
B) What did he do wrong?
C) How could he have avoided his mistake?
D) Did he follow the method for experimenting given in this unit?

ANSWER: Aristotle did not have enough data to come to the conclusion that all horses had bones in their heart. He should have dissected more horses to test his hypothesis. The horse Aristotle dissected probably had a calcium deposit in the heart. Calcium is hard, like bones.

EXPERIMENTING

Dr. King conducted a study to see how plants responded to a new soil that contained special chemicals. Dr. King grew 20 plants in the special soil and measured their growth every day for 2 months. At the end of 2 months, all of the plants had grown over 3 feet. Dr. King concluded that the special soil caused plants to grow quickly.

A) What is wrong with this experiment?

ANSWER: Dr. King did not use a control group. He cannot make conclusions about the effect of the special soil if he does not have a control group to compare with the experimental group.

B) How would you improve it?

ANSWER: He needs a control group, for example 20 plants grown in another kind of soil.

C) Was Dr. King's conclusion right?

ANSWER: We do not know if his conclusion was correct. His experiment did not allow conclusions to be made.

SPONTANEOUS GENERATION

People have often observed that rotten meat and trash often seem to "produce" flies. The baby flies seem to appear from the trash. Some people believe the flies are being born from the trash (the trash is the "parent"). This is called *spontaneous generation*.

A) Give your own hypothesis of where the flies are coming from.

1 POSSIBLE ANSWER: Perhaps the flies are coming from fly eggs that have been laid in the rotten meat.

B) Design an experiment to test your hypothesis.

POSSIBLE ANSWER: Place some meat in a place where flies cannot get to it and see if baby flies develop in the meat.

ANTHRAX

In the 1870's, a scientist named Robert Koch was investigating a disease in cows called anthrax. In examining blood from sick cows, he found that all the sick cows had small rod-shaped cells in their blood. Dr. Koch believed that these cells were causing the disease.

A) How could he check his hypothesis?

ANSWER: He could examine well cows.

B) Outline a procedure for determining if these cells caused the disease. Make sure that your procedure allows you to make predictions and observe results.

The answers will vary. Below is Robert Koch's outline.

1. **Isolate the rod cells from the sick animal.**
2. **Put the rod cells into a well animal.**
3. **See if the animal gets sick.**
4. **If the animal gets sick, look for the rod cells in its blood.**
5. **Isolate the rod cells from the second sick animal.**
6. **Put these rod cells into a well animal.**
7. **See if that animal gets sick.**
8. **If the animal gets sick, look for the rod cells in its blood.**

If the cells are present, you can assume that the rod cells probably cause the disease.

You also need a control group. One possible control is to take the rod-shaped cells out of the sample of the sick cow's blood. Inject this sample into a well cow and see if it gets sick.

AFFIXES

AFFIXES

In science, there are many new words to learn. A lot of the words seem very long or complicated. They are often hard to pronounce. This can make learning science seem very difficult. But when you look at them closely, you will see that the words are not really that difficult. Many of the words in science use ***affixes.*** Affixes are parts of words that have specific meanings. Affixes can be at the beginning of the word (**prefixes**), at the end of the word (**suffixes**), or in the middle of a word. The part of the word that carries the primary meaning is called the ***root*** or ***stem***. The same affix may be used in many different words. If you know what the affix means, you can often figure out what the word means.

For example, in the word *biology*, ***bio-*** is a root and ***ology*** is a suffix. Bio means life or living. *Biology* is the study of life; a *biography* is a book about someone's life; *biochemistry* is the study of the chemistry of living things. Knowing what *bio-* means gives you a clue to the meaning of many other words. This unit lists some common affixes and their meanings. There are also some exercises to give you practice in using your knowledge of affixes.

AFFIX	MEANING
a —	not; without
anti —	opposite; against
aqua —	water
bi —	twice or two
bio —	life
cardia —	heart
centi —	hundred
com —	together
cyto —	relating to the cell
cycl —	round
derma —	skin
di —	two
diplo —	double
dis —	apart; not
duo —	two, twice
e —	without
endo —	inside
epi —	over; on top of
eu —	good; truly
ex —	without; lacking
exo —	outside

gastr —	stomach; belly
geo —	earth
gyn —	woman; female
hab —	have; hold; occupy
halo —	salt
haplo —	single
hemi —	half
hetero —	different
homo —	same
hydro —	water
hyper —	over; above
hypo —	under; below; lower
in —	not; without
inter —	between
intra —	within
iso —	equal
lepid —	scale
lun —	moon
macro —	large; long
mega —	big; great
meso —	middle
meter —	measurer

micro —	small
milli —	thousand
mono —	one; single
neo —	new; young
neur —	nerve
non —	not
ology —	the study of
ovi —	egg
patho —	relating to disease; suffering
ped —	foot
phil —	love
photo —	light
phyt —	plant
pod —	foot
poly —	many
pre —	before
pseudo —	false
pter —	wing; feather
ren —	kidney
retro —	backward
semi —	half
sol —	sun

sub — under; after

super — above; over

sym — together

tel — far away

terra — land; earth

therm — heat

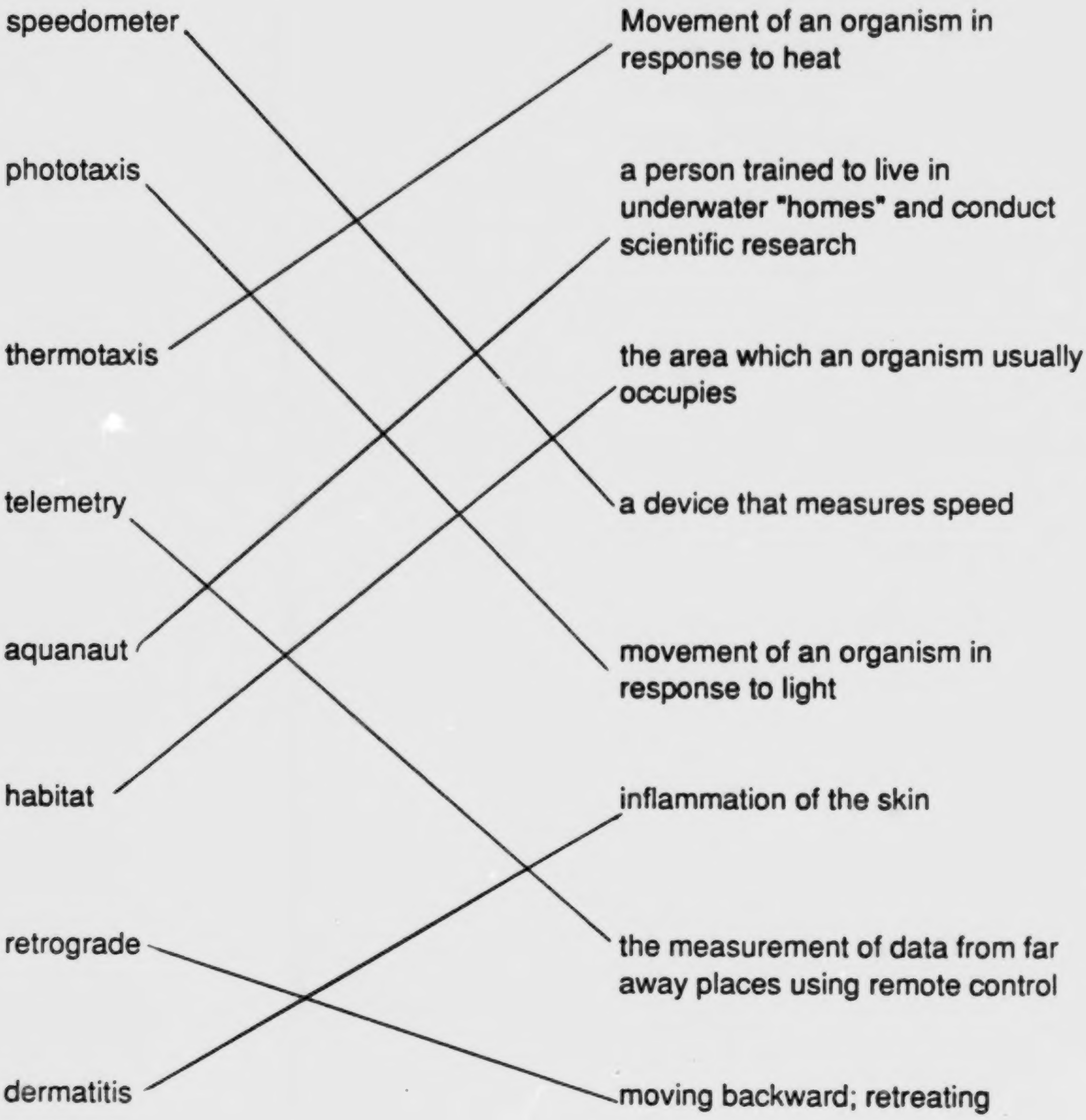
tri — three

uni — one

zo — animal

MATCHING

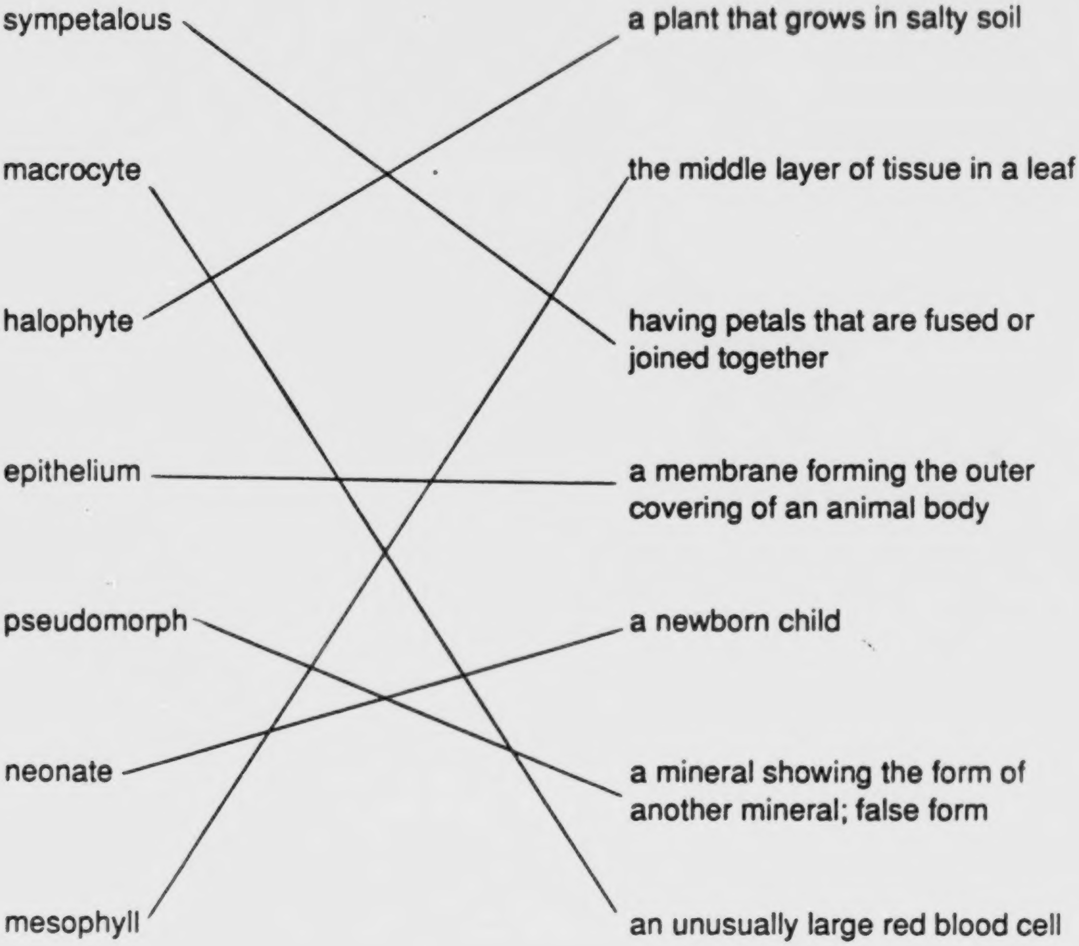
Sometimes knowing the affixes can make you figure out the meaning of even very outrageous looking words. How many can you figure out? Match each word on the left with the correct definition on the right. Each word contains an affix. Look the affixes up in the glossary if you are not sure of the meaning.



speedometer	Movement of an organism in response to heat
phototaxis	a person trained to live in underwater "homes" and conduct scientific research
thermotaxis	the area which an organism usually occupies
telemetry	a device that measures speed
aquanaut	movement of an organism in response to light
habitat	inflammation of the skin
retrograde	the measurement of data from far away places using remote control
dermatitis	moving backward; retreating

MATCHING

Sometimes knowing the affixes can make you figure out the meaning of even very outrageous looking words. How many can you figure out? Match each word on the left with the correct definition on the right. Each word contains an affix. Look the affixes up in the glossary if you are not sure of the meaning.



sympetalous	a plant that grows in salty soil
macrocyte	the middle layer of tissue in a leaf
halophyte	having petals that are fused or joined together
epithelium	a membrane forming the outer covering of an animal body
pseudomorph	a newborn child
neonate	a mineral showing the form of another mineral; false form
mesophyll	an unusually large red blood cell

SIZE

Circle the word in each group that is probably the largest or the one that contains the most of something.

1. bicycle
[✓ tricycle]
unicycle
hemicycle

2. haploid
[✓ diploid]

3. monopode
centipede
[✓ millipede]
tripod
biped

4. [✓ macroscopic]
microscopic

5. microspore
[✓ megaspore]

6. [✓ polygamous]
bigamous
monogamous

7. [✓ hyperacidic]
hypoacidic

8. What do all the items in number 1 have in common?
ANSWER: They all contain circles or wheels. Remember that cycl means round.

9. What do all the items in number 3 have in common?
ANSWER: They all tell about the number of feet. Remember that ped, pod, and pede all mean feet.

OPPOSITES

1. Which word describes a place closest to the earth?

   [✓ a) sublunar]
   b) superlunar

2. A skeleton is the hard structure that provides support to an organism (like bones). What is the difference between an ***endoskeleton*** and an ***exoskeleton*** ?

ANSWER: An *endoskeleton* is a skeleton found inside the animal's body. An *exoskeleton* is a skeleton found on the outside of the animal's body.

3. What is the difference between ***interstate*** and ***intrastate***?

ANSWER: *Interstate* describes things that happen between states. *Intrastate* describes things that happen within a state.

4. Which word describes things happening inside one cell?

   a) intercellular
   [✓ b) intracellular]

What does the word you did not choose mean?

ANSWER: Intercellular means things happening between cells.

GUESSING MEANINGS

1. Each word below describes a person who studies something special. See if you can guess what each person studies. Write what the person studies on the line next to the word.The affixes in each word give you a clue.

Dermatologist	skin
Cytologist	cells
Pathologist	diseases
Biologist	living things
Geologist	Earth
Cardiologist	the heart
Gastrologist	the stomach
Neurologist	the nervous system
Podiatrist	feet
Zoologist	animals
Microbiologist	small living things

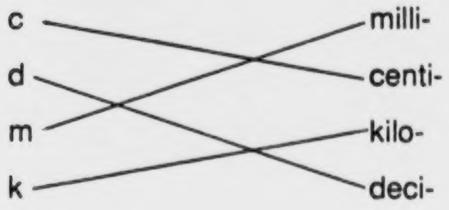
2. Below are the scientific games of some insects. Try to describe the wings of each insect by figuring out what the name means. Can you guess what insects each name describes?

Lepidoptera	wings with scales on them (butterflies & moths)
Dermaptera	wings that feel like skin (earwigs)
Isoptera	wings that are all equal in size (termites).
Diptera	only two wings (flies & mosquitoes)
Homoptera	wings all look alike (aphids & cicadas)

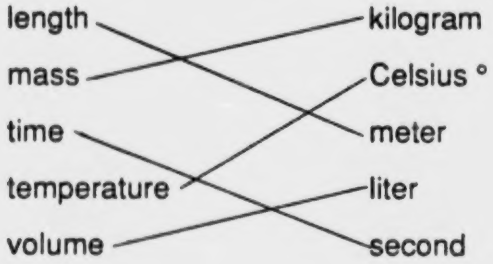
MEASUREMENT

MEASUREMENT

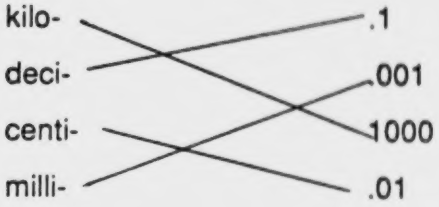
1. Match each symbol on the left to the prefix on the right that it stands for.


c
d
m
k
milli-
centi-
kilo-
deci-

2. Match each type of measurement on the left with its unit.

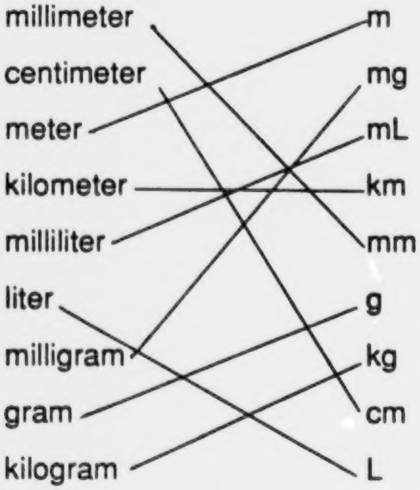

length
mass
time
temperature
volume
kilogram
Celsius °
meter
liter
second

3. Match each prefix on the left with its multiplier.


kilo-
deci-
centi-
milli-
.1
.001
1000
.01

MEASUREMENT

4. Match each unit on the left with its symbol.


millimeter
centimeter
meter
kilometer
milliliter
liter
milligram
gram
kilogram
m
mg
mL
km
mm
g
kg
cm
L

CONVERTING MEASUREMENTS

To convert from one unit to another in the metric system, you need to know ***base units*** and what the prefixes mean. The process is called ***conversion***. The base units are standard units. Other units are described in terms of base units. The ***prefixes*** on a unit name tells you how a unit compares with a base unit. For example, a milliliter is one thousandth as big as a liter. The *milli-* part means *one thousandth*. So to make a liter, you would need one thousand milliliters.

Here are some examples of conversion in the metric system.

A. **111 meters is how many kilometers?**
Kilo- means *a thousand*; one kilometer is a thousand times bigger than a meter. Another way to say this is one meter is one thousandth as big as a kilometer. So to get the answer, multiply 111 meters by one thousandth (.001). You get .111 Km.

B. **38 centimeters is how many decimeters?**
Centi- means *a hundredth* and *deci-* means *a tenth*. So a centimeter is a hundredth as big as a meter and a decimeter is a tenth as big as a meter. That means a decimeter is ten times bigger than a centimeter. Or you could say that a centimeter is one tenth the size of a decimeter. So to get the answer, multiply 38 centimeters by one tenth (.1). You get 3.8 decimeters.

C. **.092 liters is how many milliliters?**
Milli- means *one thousandth*. That means a milliliter is equal to one thousandth of a liter. So if it takes a thousand milliliters to make a liter, multiply .092 by a thousand to get the answer. The answer is 92 mL.

CONVERSION

1. 4 centimeters = .04 meters

ANSWER: Centimeters are smaller than meters. It takes 100 centimeters to make one meter. So, 4 cm = 4/100 m = .04 m.

2. .18 meters = 180 millimeters
3. 3010 millimeters = 301 centimeters
4. 7.5 meters = 750 centimeters
5. 222 centimeters = 2,220 millimeters
6. 46 millimeters = .046 meters
7. 71.3 centimeters = .713 meters
8. 4900 millimeters = 4.9 meters
9. 5 liters = 5000 milliliters
10. 60.7 milliliters = .0607 liters
11. 840 milliliters = .84 liters
12. .039 liters = 39 milliliters
13. 95 grams = .095 kilograms
14. .058 kilograms = 58,000 milligrams

ANSWER: .058 kg = 58 g = 58,000 mg

15. 67 milligrams = .067 grams
16. 8.1 kilograms = 8100 grams
17. 32 grams = 32,000 milligrams
18. 7400 milligrams = .0074 kilograms

ANSWER: 7400 mg = 7.4 g = .0074 kg

19. 290 grams = .29 kilograms
20. 654,321 milligrams = .654321 kilograms

CLASSIFICATION

CLASSIFICATION

List some things that are not alive and explain how you know they are not alive.

Examples:

- **rocks**
- **metal**
- **water**
- **cars**

List some things that are alive and explain how you know they are alive.

ANSWERS WILL VARY

Examples:

- **trees**
- **birds**
- **mushrooms**
- **bacteria**

What is the difference between the things you listed and things that are not alive? Turn the page if you are having difficulty here. The next pages describe living things.

WHAT MAKES SOMETHING ALIVE?

Biologists (scientists who study life) have observed many different kinds of living things. By comparing the characteristics of all of these living things, biologists have learned that all living things do certain things. These things that all living things do are called ***life functions.*** The following chart lists the eight life functions, a definition for each one, the importance of each one to life, and the processes that are involved in performing that life function.

Name of Life Function	Definition of Life Function	Importance of Life Function	Activities Invol in Life Function
1. Nutrition (eating)	The process by which a living thing takes food from its environment and uses it for energy and growth	Makes it possible for the living thing to grow and develop	*ingestion* - gettin consuming th *digestion* - changi the food into a the body can us
2. Transport (moving substances)	The process by which substances are moved from place to place within the body	Makes it possible for substances to get to the parts of the body that can use them	*diffusion* - movem to distribute a substance equally *circulation* - the movement of fluid through the body
3. Respiration (breathing)	The process of bringing in oxygen and using it for metabolic processes	Makes it possible for food to be converted to energy	*breathing* - the pumping of oxyg into the body *cellular respirati* the chemical cess of getting energy from using oxygen other chemi
4. Excretion (waste removal)	The process by which waste (unnecessary or harmful substances) is released by the body	Prevents harmful waste products (such as ammonia) from "poisoning" the body	Excretory cell organs remov from the body it into the er

5. Synthesis (making substances)	The process by which small molecules are built into larger ones	Makes it possible for the body to make enzymes and other complex chemicals the body needs	*Ribosomes* - make proteins in the cells
6. Regulation (controlling the life functions)	The process by which the life functions of a living thing are controlled	Makes sure that the body does the right thing at the right time	*Nervous System* - controls movement and the body's awareness of itself *Endocrine System* - makes hormones which trigger many body activities
7. Growth	The process by which the size and number of cells increase	Allows the living thing to get larger and mature (become an adult)	*Mitosis* - a type of cell division which makes new cells
8. Reproduction	The process by which new living things are made by existing ones	Prevents living things from becoming extinct (disappearing from the earth)	

WHAT IS NECESSARY FOR LIFE?

Put a check mark next to all the processes that are ***necessary*** for living organisms.

_X__ Eating

_X__ Transportation of substances in the body

_X__ Respiration (breathing)

____ Seeing

_X__ Removing waste

____ Body movement

_X__ Regulation of body functions

_X__ Growth

_X__ Reproduction

____ Hearing

____ Erosion

The Classification of Living Things

All living things share the characteristic of being alive--that is, they carry out the life functions of eating, growing, developing, using energy, and reproducing. What other characteristics do living things have in common? The answer depends on which living things you compare. A cat and a dog have many additional characteristics in common; a cat and a rose do not share additional characteristics. A rose has more in common with an oak tree than with a cat. Dogs, cats, roses, and oak trees fall into two different groups of living things called **animals** and **plants**. The difference between them is known as a **group difference**.

Biologists often need to talk about group differences. To make these discussions easier, they have developed a system of classification for living things. This ***classification system*** does two important things: 1) it groups living things by their similarities and differences and 2) it gives a different name to every living thing on the earth so biologists can avoid the problem of having two plants or animals with the same name.

This classification system has 7 main levels. They are listed below.

- Kingdom
  - Phylum
    - Class
      - Order
        - Family
          - Genus
            - Species

It is a ***hierarchical*** system, which means that these 7 levels must always stay in the order given here. Each level includes all the levels below it. The **kingdom** includes the 6 lower levels--**phylum, class, order, family, genus, and species**. The **phylum** includes the 5 lower levels--**class, order, family, genus, and species**; and so on for all the levels. Each level gets its name from the groups within it--the level **kingdom** contains 5 groups called **kingdoms**; the level **order** contains different groups called **orders**, etc.

An easy way to remember the correct order of the groups is to memorize the sentence below. The first letter of each word in the sentence is the same as the first letter in one of the groups in the classfication system.

Keep	potato	chips	out	for	good	snacks.
Kingdom	phylum	class	order	family	genus	species

WHICH ARE ALIKE?

Read the following pairs of statements. Choose the statement that describes the organisms that would have the most in common. **Hint:** Those things that are further down the classification chart are more alike.

Which would have the most in common,

1. 2 organisms in the same phylum ___
or 2 organisms in the same genus? _X_

2. 2 organisms in the same family _X_
2 organisms in the same order ___

3. 2 organisms in the same species _X_
2 organisms in the same genus ___

4. 2 organisms in the same species _X_
2 organisms in the same phylum? ___

5. 2 organisms in the same subphylum _X_
2 organisms in the same phylum ___
HINT: ***Sub*** means under.

At which level (kingdom, etc.) would the members of that group have the most in common?
ANSWER: SPECIES. Species is the bottom of the classification system. The members of the same species are very similar. For example, all humans belong to the same species. Humans are very different from horses. Horses belong to a different species.

At which level would the members of that group have the least in common?
ANSWER: KINGDOM. Kingdom is the top of the classification system. It gives the widest description of organisms. For example, all animals are in the same kingdom. Obviously, animals are very different. They have very little in common.

WHICH HAS THE MOST?

Circle the group in each list which probably contains the most organisms.

1. [✓ class]
   order

2. genus
   [✓ family]
   species

3. [✓ phylum]
   class

4. [✓ class]
   subclass
   order

Hint: *Sub-* means under.

5. family
   [✓ superorder]
   order

Hint: *Super-* means bigger

6. superclass
   phylum
   [✓ kingdom]

7. subspecies
   [✓ genus]
   species

8. [✓ kingdom]
   species

Can you think of a situation where an order would contain more organisms than a class?

ANSWER: A class only contains more organisms than an order if the order comes under that class. For example, humans and snails belong to different classes. The order that snails belong to contains more organisms than the class that humans belong to. Obviously, the order that snails belong to also contains more organisms than the order that humans belong to.

WHAT MAKES A SPECIES?

Put a check mark by the statements below that are true for all members of a species.

X___ Can produce fertile offspring

____ Are the same color

____ Belong to different families

____ Live in the same area

____ Look identical

X___ Belong to the same genus

____ Are animals

X___ Have many of the same characteristics

List the statements you did not check. Next to each, tell why it is not always true of members of the same species.

ANSWERS:

Are the same color - Members of the same species may differ in color. Species does not mean that all physical characteristics are the same.

Belong to different families — Members of the same species must belong to the same family. Remember that classification is hierarchical.

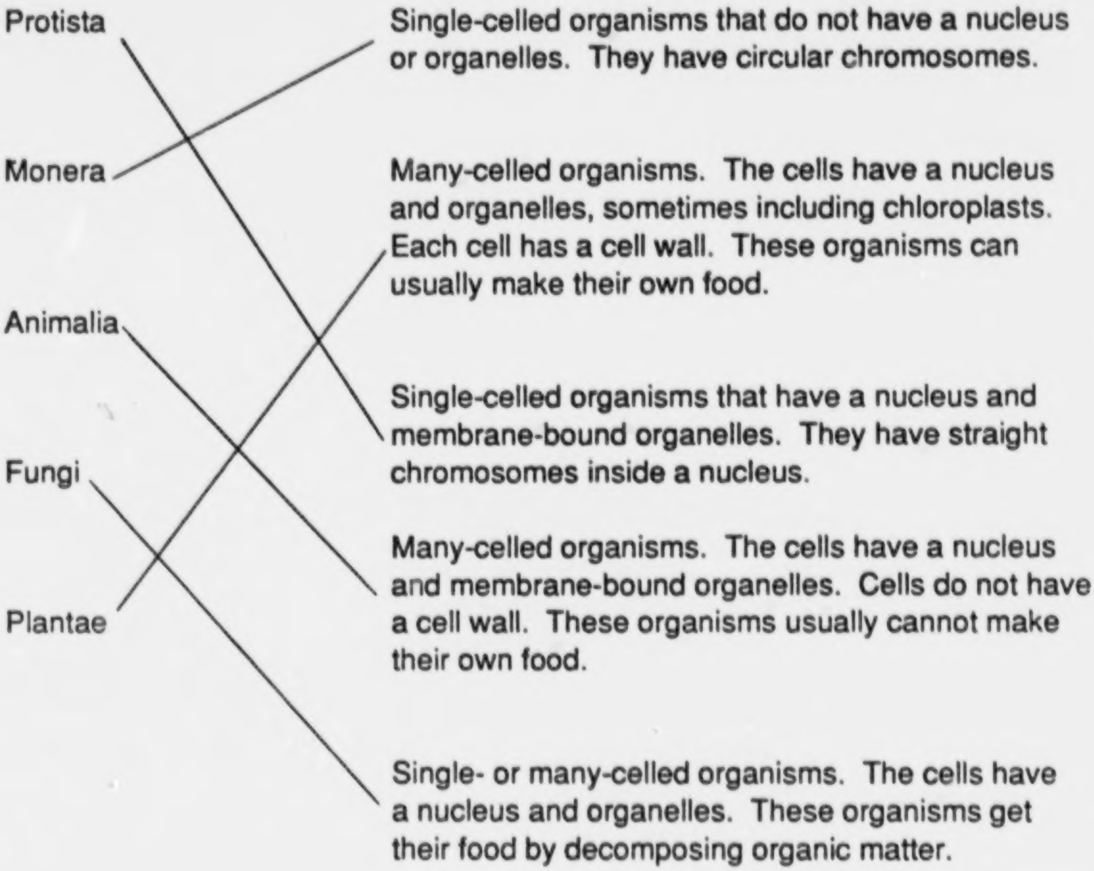
Live in the same area — Members of a species do not have to live together. Sometimes members of a species are found thousands of miles apart.

Look identical — Members of a species usually do not look identical. There is always variation in physical characteristics. (Do all humans look identical?)

Are animals — The term *species* does not apply only to animals. Plants, bacteria, fungus, and all other organisms are given species names.

THE 5 KINGDOMS

Match the kingdom name on the left with the correct description on the right.



Protista

Monera

Animalia

Fungi

Plantae

Single-celled organisms that do not have a nucleus or organelles. They have circular chromosomes.

Many-celled organisms. The cells have a nucleus and organelles, sometimes including chloroplasts. Each cell has a cell wall. These organisms can usually make their own food.

Single-celled organisms that have a nucleus and membrane-bound organelles. They have straight chromosomes inside a nucleus.

Many-celled organisms. The cells have a nucleus and membrane-bound organelles. Cells do not have a cell wall. These organisms usually cannot make their own food.

Single- or many-celled organisms. The cells have a nucleus and organelles. These organisms get their food by decomposing organic matter.

(Organelles are small structures inside a cell. Refer to the unit on the Cell for information about organelles and other cell parts.)

DICHOTOMOUS KEYS

A ***dichotomous key*** is a guide for identifying and classifying living things. Dichotomous keys can be made for all levels in the classification system.

Each key consists of several pairs of statements. The first statement in each pair describes one characteristic, and the second statement in the pair describes the *opposite* characteristic. Each statement always describes the same structure on the organism (like the leaf of a plant).

Here are the steps for using a dichotomous key:

1. Select the organism you want to identify.
2. Start with pair #1.
3. Read both statements in the pair.
4. Select the statement that best describes your organism.
5. If the statement you chose is followed by a number, go to the pair that has that number. Repeat steps 3-5.
6. If the line you chose is followed by a name, you may stop. You have identified your organism.

A. Can you think of some situations where it would be helpful to identify an organism?

For example, your dog is losing hair. You see small bugs. Are they fleas?

B. In what areas of biology do you think these keys are used?

ANSWER: They are used in many areas: microbiology, botany, zoology, entomology, etc.

C. How is a key related to the classification of organisms?

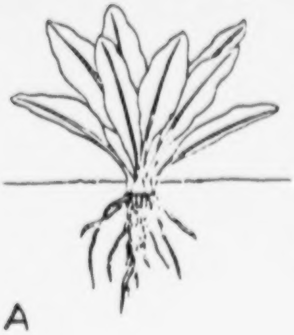
ANSWER: A key describes organisms based on their differences and identifies them to a certain classification level.

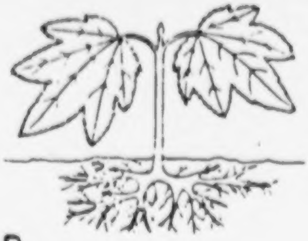
D. Why do you think this is called a "key"?

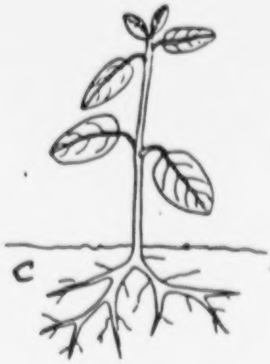
ANSWER: Perhaps because it "unlocks" the identity of the unknown organism.

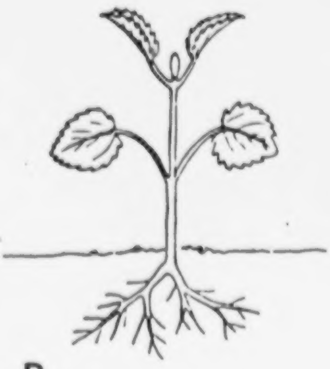
PRACTICE WITH A DICHOTOMOUS KEY

Below is an example of a dichotomous key. Use the key to identify the imaginary plants drawn below. Write the name for each organism next to the letter for each at the bottom of the page.


A


B


C


D

KEY TO IMAGINARY PLANTS

1a.	Has a stem	2 (go to pair #2)
1b.	Doesn't have a stem	Acaulescent
2a.	Leaves have serrated (rough) edges	3
2b.	Leaves have smooth (entire) edges	Entirata
3a.	Leaves are longer than 1 centimeter	Longus
3b.	Leaves are not longer than 1 centimeter	Minutae

Write the name of the organisms as you identified them using the key above.

A. Acaulescent

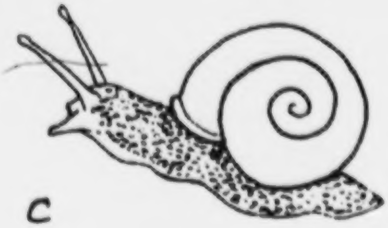
B. Longus

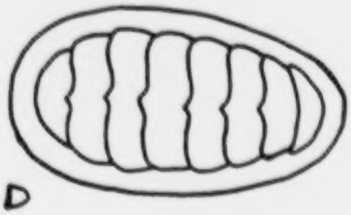
C. Entirata

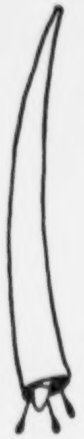
D. Minutae

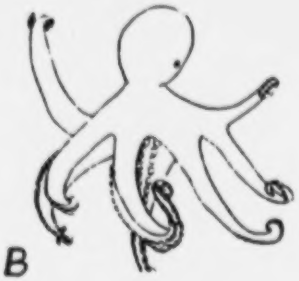
IDENTIFYING SOME MOLLUSKS

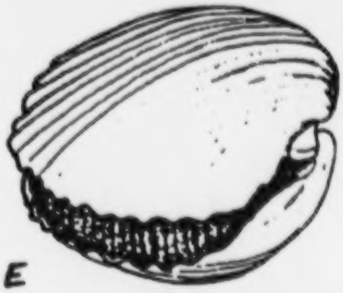
Using the key at the bottom of the page, identify the organisms that are drawn below.


C


D


A


B


E

KEY TO THE CLASS OF SOME MOLLUSKS

1a. Has a shell 2
1b. Doesn't have a shell . . . . Cephalopoda
2a. Shell is in one piece. 4
2b. Shell is in more than one piece 3
3a. Shell is in two pieces . . . . Bivalvia
3b. Shell is in more than two pieces. Polyplacophora
4a. Shell is spiraled (twisted). . . . . .Gastropoda
4b. Shell is not spiraled . . . . .Scaphopoda

Write the class of the organism beside the appropriate letter.

A. Scaphopoda

B. Cephalopoda

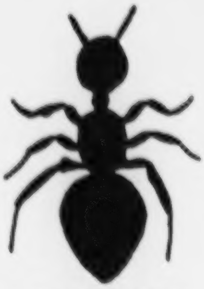
C. Gastropoda

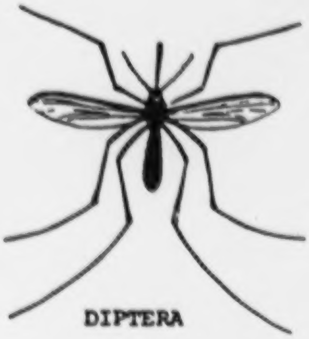
D. Polyplacophora

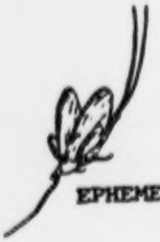
E. Bivalvia

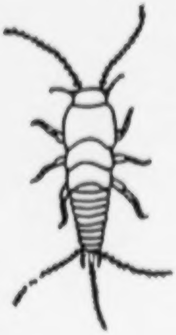
COMPLETE THE KEY

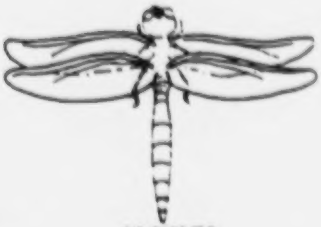
Below is an unfinished dichotomous key for the organisms drawn below. Fill in the blanks in the key using the information you are given and what you know about dichotomous keys.

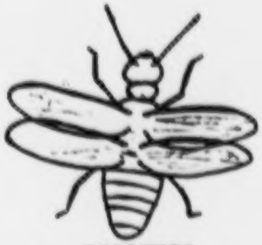

HYMENOPTERA

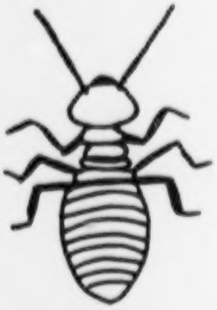

DIPTERA


EPHEMEROPTERA


THYSANURA


ODONATA


ISOPTERA


ISOPTERA

A KEY TO THE ORDER OF SOME INSECTS

1a. Has wings 2
1b. Doesn't have wings 5
2a. Has two wings . . . . Diptera
2b. Has four wings 3
3a. Wings are about the same size 4
3b. Wings are not the same size . . . . Ephemeroptera
4a. Body is very thin . . . . Odonata

4b. Body is not very thin. . . . . Isoptera
5a. Body white 6
5b. Body not white . . . . Hymenoptera
6a. Has 3 thin tails . . . . Thysanura
6b. Does not have 3 thin tails. Isoptera

WRITING A DICHOTOMOUS KEY

Now you write a dichotomous key using the characteristics of the organisms listed below. Pick the characteristics that will be the easiest to recognize and describe. You might use a characteristic more than once or you might not use a characteristic at all.

	Violet	Lily	Strawberry	Mint
Stems	herbaceous	herbaceous	herbaceous	herbaceous
Leaf type	compound	simple	compound	simple
Veins	net	parallel	net	net
Petal Color	purple	yellow	yellow	purple
Flowers symmetrical?	No	No	Yes	No

Below is 1 possible way to write the key. As long as your key works, it is correct.

1a. Veins are parallel . . . . Lily
1b. Veins are not parallel 2
2a. Petals are yellow . . . . Strawberry
2b. Petals are not yellow 3
3a. Leaves are simple . . . . Mint
3b. Leaves are not simple (are compound) . . . . .Violet

Were there any characteristics that you did not use? If so, which ones?
ANSWER: Stem type should not have been used, since it is the same for all the plants. The sample key above also did not use flower symmetry, because it was not needed. There may have been different characteristics you did not use. It depends on how you wrote your key.

Is there more than one way to write this key? Why or why not?
ANSWER: Yes. There is more than one way to write the key. The organisms have many characteristics. You can combine the characteristics in many ways to write the key. For exmple, you could use leaf type before petal color.

A KEY TO THE KINGDOMS

Write a dichotomous key to distinguish the five kingdoms: Monera, Protista, Plantae, Fungi, and Animalia. Start by listing the characteristics that distinguish each kingdom. Some characteristics have been listed to get you started.

	Monera	Protista	Fungi	Plantae	Animalia
number of cells?	1	1	1 or more	many	many
cell wall?	Yes	No	No	Yes	No
nucleus?	No	Yes	Yes	Yes	Yes
Nutrition?	Varies	Varies	Decomposition	Makes own food	Eats

The key below is only 1 of many possible keys. As long as the key you wrote works, it is correct.

1a.	Has a nucleus	2
1b.	Doesn't have a nucleus	Monera
2a.	Always 1-celled	Protista
2b.	Not always 1-celled	3
3a.	Cells have cell walls	Plantae
3b.	Cells do not have cell walls	4
4a.	Decomposes organic matter for food	Fungi
4b.	Does not decompose organic matter for food	Animalia

THE CELL

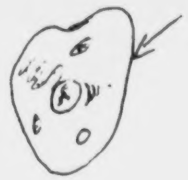
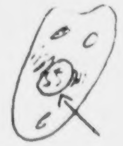
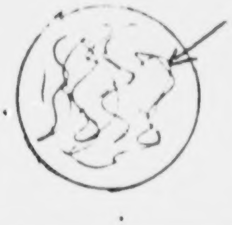
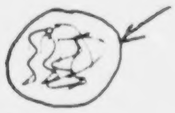
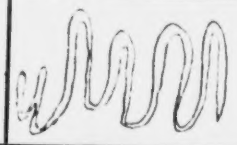
THE CELL

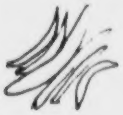
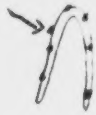
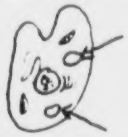
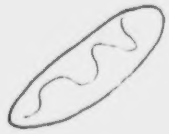
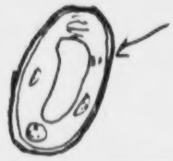
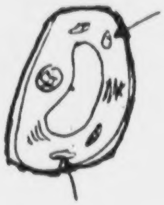
All organisms are made up of small units called ***cells***. Cells are also living things. They are the smallest living things. There are even some organisms that consist of only one cell! Plants and animals, however, have many cells. Everything that happens to an organism actually happens to a cell. And everything that an organism does is actually done by a cell. When you raise your hand, the cells in your brain send messages through the cells of your nervous system to the muscle cells in your arm and hand. The muscle cells cause your hand to be lifted.

An ***organism*** is a collection of cells that work together. Usually, each cell does a specific job for the organism that it is part of. Blood cells perform different functions from skin cells; brain cells perform different functions from muscle cells. But all cells have similar parts and carry on their processes in similar ways.

PARTS OF A CELL

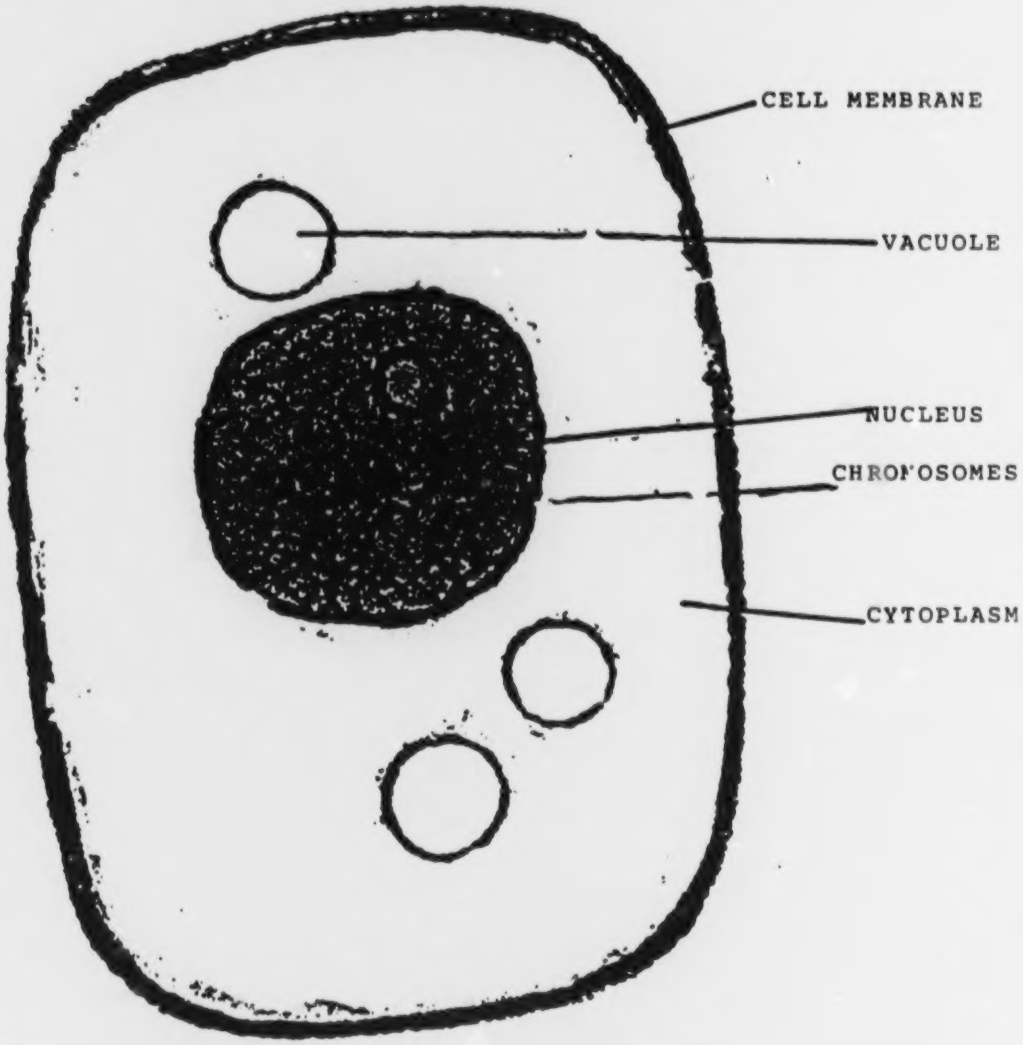
The following chart explains the structures within the cell. Most cell structures are ***organelles***. The first column gives the name of the cell part (organelle); the second column describes the cell function; and the third column provides an illustration of the part. Fill in the missing parts. You should use your book for help.

Name of Cell Part	**Function**	**Drawing**
cell membrane	the outer boundary or "skin" of a cell which controls the movement of substances (especially water) into and out of the cell.	
cytoplasm	the living material inside a cell. It is clear and gel-like.	
nucleus	An area inside the cell surrounded by the nuclear membrane. It contains the chromosomes and controls the cell's activities.	
chromosomes	structures inside the nucleus that contain the genes of the cell. They tell the cell how to function and reproduce. They are long and thin like threads.	
nuclear membrane	the outer boundary or "skin" of the nucleus	
endoplasmic reticulum	a system of tubes that moves substances throughout the cell	

Name of Cell Part	**Function**	**Drawing**
Golgi bodies	structures that store cell wastes and transport them to the cell membrane where they leave the cell	
ribosomes	structures that make proteins for use by the cell. Ribosomes are found throughout the cell, but they are often found on endoplasmic reticulum.	
vacuoles	structures that keep food or other substances in the cell away from cytoplasm	
mitochondria	the structure where cells carry out a complex chemical reaction (cellular respiration) that turns food into energy.	
Plant cells have 2 additional parts that animal cells do not have:		
cell wall	a tough, stiff "skin" outside the cell membrane. It gives the plant support, like bones support animals	
chloroplasts	structures that contain chlorophyll which use sunlight to make food for the plant.	

In the drawing of a cell below, label the indicated structures. Draw in the missing organelles.

Animal cell


CELL MEMBRANE
VACUOLE
NUCLEUS
CHROMOSOMES
CYTOPLASM

Please add:
- Golgi bodies
- Endoplasmic reticulum
- Mitochondria
- Ribosomes

LIFE FUNCTIONS

Since cells are living things, they must carry out the essential life functions. In the space provided below, give the name of the cell part that carries out each function listed. Look at the chart you just filled in for help.

Nutrition
cell membrane, lysosomes, and vacuoles

Cell Respiration
mitochondria

Transportation
Golgi bodies
Endoplasmic reticulum
vacuoles

Synthesis
ribosomes

Excretion
vacuoles
cell membrane
Golgi bodies

Reproduction
nucleus
chromosomes

BUILDING BLOCKS

Match each organic compound with the proper description.

Carbohydrates	Hydrogen, carbon, and oxygen. Used mostly for energy. (Sugars)
Lipids	Hydrogen, carbon, oxygen and nitrogen. Made of amino acids. Used for enzymes, hormones, etc.
Proteins	Complex organic compound (DNA & RNA) that carries hereditary information.
Nucleic Acid	Hydrogen, carbon, and oxygen. Used for energy and membrane construction.

OSMOSIS

A worm is weighed. Then it is placed in a bowl of water. The worm is taken out and weighed every 15 minutes. The results are given in the table below. From this information, decide whether the water in the bowl had a greater or lesser concentration of dissolved substances than the worm's body fluids.

Time:	0 minutes	15 minutes	30 minutes	45 minutes
Weight:	15 grams	14 grams	10 grams	6 grams

ANSWER: The water had more dissolved substances. The worm is losing water. This is why the weight is decreasing. Osmosis moves water from areas of lesser concentration of dissolved substances to areas of greater concentration of dissolved substances. Therefore, the water in the bowl must have a greater concentration of dissolved substances than the worm's body.

ORGANIZATION

Cells in many-celled organisms can all be alike. Very often, however, the cells are ***specialized*** . All the cells are not alike. Each cell or group of cells does a specific job. This is called ***division of labor***. When cells which perform the same function are grouped together, they are called a ***tissue***. Several tissues which work together to perform a funciton are called an ***organ***. Several organs that interact to perform a function are called an ***organ system***.

For example, the cells that line the stomach are all alike. They secrete certain chemicals and perform other functions. These cells together are called a ***tissue***. The muscle cells that cover the outside of the stomach are responsible for moving the stomach. These cells are also a ***tissue***. All the tissues in the stomach work together to perform the function of digestion. Therefore the stomach is an ***organ***. The stomach is not the only organ that digests food. The esophagus and the intestines also help digest food. The esophagus and the intestines are also ***organs***. The esophagus, stomach, and intestines are organs that work together to perform digestion. These organs together are called the digestive ***system.***

WHAT IS MITOSIS?

All cells must copy themselves at some time during their life. New cells must be produced to take the place of cells that have died or have been lost (for example, you lose blood cells if you cut yourself and you bleed). The new cells are formed by cell division, or ***mitosis***. Every new cell formed by mitosis is identical in many ways to the original cell, that is, the new cell and the original cell contain the same genetic information. They both have a complete set of identical chromosomes.

Sometimes the cell that copies itself is a one-celled organism. In this case, mitosis has produced a new, complete *organism* identical to the original. This is reproduction. Specifically, it is a kind of ***asexual reproduction*** (***binary fission***) because one original organism produces a new organism by dividing itself.

STEPS IN MITOSIS

1. The ***chromosomes*** in the nucleus replicate so there are two complete sets in the cell. The copy of each chromosome is connected to the chromosome that made it. This is a ***replicated pair.***

2. The chromosomes become thicker and shorter.

3. The ***nuclear membrane*** surrounding the nucleus breaks apart and disappears so the chromosomes are free to move.

4. ***Spindle fibers*** form from the middle of the cell to the ends of the cell.

5. The chromosomes line up in the middle of the cell.

6. The replicated pairs separate at the center and move to opposite ends of the cell. Each end of the cell now contains a complete set of chromosomes.

7. The spindle fibers disappear.

8. A new nuclear membrane forms around each set of chromosomes.

9. The ***cell membrane*** and ***cytoplasm*** divide between the two nucleuses, leaving two complete cells.

SEQUENCE

Below are the steps of mitosis. They are in the wrong order. The pictures at the bottom show the sequence of mitosis. Write the letter of the correct step under each picture. Some pictures may have more than one letter.

A. The replicated pairs separate.

B. Spindle fibers disappear and chromosomes are clumped at the poles.

C. The nuclear membrane begins to break apart and disappear.

D. The chromosomes line up at the equator.

E. Chromosomes replicate, leaving 2 complete sets of chromosomes.

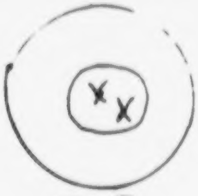
F. Spindle fibers form from the middle to the ends of the cell.

G. The cytoplasm divides, creating 2 completely separate cells.

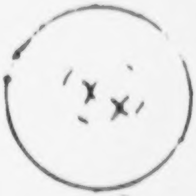
H. A nuclear membrane reforms around each bundle of chromosomes at the ends of the cell.

I. The separated chromosomes move toward the ends of the cell.

J. Chromosomes become shorter and thicker.



J, E



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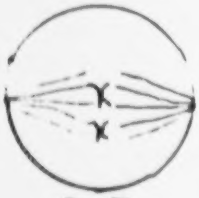
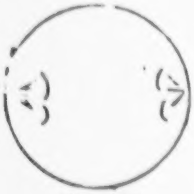
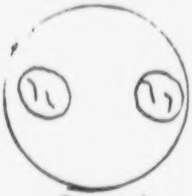


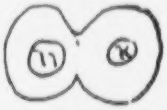
D, F

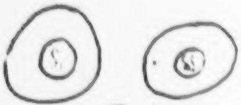


A, I



B, H





G

QUESTIONS ABOUT MITOSIS

Answer the questions below about mitosis.

1. a) What happened to the original cell after mitosis?
Answer: The original cell no longer exists as a cell. It was split into two new cells.

b) Are the two new cells bigger or smaller than the original cell?
Answer: The two new cells are smaller than the original cell.

c) Why?
Answer: The original was split in half during mitosis. The new cells each contain a complete set of chromosomes, but half of the rest of the original cell. But, each new cell is a complete cell.

2. a) Is mitosis a form of *reproduction* in many-celled organisms?
Answer: No. Reproduction means that a new organism is created. Mitosis creates new cells in many-celled organisms, but it does not create a whole new organism. For example, when the cells in your body go through mitosis, they do not create another person.

b) Is mitosis a form of *reproduction* in single-celled organisms?
Answer: Yes. Some single-celled organisms reproduce simply by going through mitosis. Since mitosis in this case results in new organisms, it is considered reproduction.

c) In what ways could many-celled organisms use mitosis?
Answer: Many-celled organisms use mitosis to grow. This is how they create new cells to carry on life functions and to make the organism bigger.

BACTERIA

BACTERIA

Bacteria are one-celled organisms. (***Bacterium*** is used for 1. Bacteria is for 2 or more.) They do not have organelles (such as mitochondria, nucleus). They do have many ***ribosomes*** (structures that make proteins). Bacteria have 1 chromosome and it is in a circle. Most have a ***cell wall***, a structure surrounding the cell membrane that gives support and structure to the cell.

GROWTH OF BACTERIA

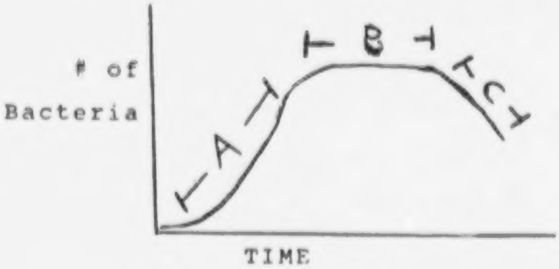
1. Generation time is the period of time it takes for a bacterium to divide and produce a new bacterium. For instance, if you have five bacteria and the generation time is 30 minutes, you would have 10 bacteria after 30 minutes and 20 bacteria after 1 hour. From the information below, determine the generation time of the bacteria.

   Number of bacteria at beginning: 1,000
   Number of bacteria after **1 HOUR**: 4,000

   How many bacteria will you have after two hours? 16,000 ?

   What is the generation time? 30 minutes ?

2. Below is a graph of the number of live bacteria in a culture over time. Explain what is happening to make the graph appear as it does in areas A, B, and C.



Hints: What two processes are going on at all times in the bacteria population that affect the number of bacteria? Think about the rates of the two contrasting processes and how the difference between them would affect the number of live bacteria.

Answer: The two processes are birth and death. In area A, the bacteria are actively dividing. Very few are dying. In area B, more of the bacteria start to die and fewer are dividing. This makes the number of bacteria stay the same. The death rate increases because competition between the bacteria is increasing. In area D, more bacteria are dying than are dividing. The food supply is running out. The bacteria wastes are piling up. They are poisoning the bacteria.

BACTERIAL KEY

Write a dichotomous key to distinguish these bacteria. Read the test results at the bottom to determine important characteristics of the bacteria. (Instructions for constructing dichotomous keys can be found in the CLASSIFICATION Unit, p. 38).

1. *Bacillus anthracis*
2. *Clostridium perfringens*
3. *Corynebacterium diptheriae*
4. *Mycobacterium tuberculosis*
5. *Streptococcus pyogenes*

Tests:

A. Is bacterium rod-shaped?
B. Is bacterium cocci-shaped (round)?
C. Does bacterium have spores?
D. Does bacterium grow in air?
E. Does bacterium grow on glucose?
F. Is bacterium motile (can it move)?

TEST RESULTS

	A	B	C	D	E	F
1	+	-	+	+	+	-
2	+	-	+	-	+	-
3	+	-	-	+	+	-
4	+	-	-	+	-	-
5	-	+	-	+	+	-

+ = positive result
- = negative result

Now read each line. For example: *Bacillus anthracis* is rod-shaped, has spores, grows in air, and grows on glucose. It is not round and it does not move.

Below is one possible key. Any key that works would be correct.

1a. Bacterium is cocci-shaped . . . . *Streptococcus pyogenes*
1b. Bacterium is not cocci-shaped (is rod-shaped) 2
2a. Bacterium grows in air 3
2b. Bacterium does not grow in air . . . . *Clostridium perfringens*
3a. Bacterium grows on glucose 4
3b. Bacterium does not grow on glucose . . . . *Mycobacterium tuberculosis*
4a. Bacterium has spores . . . . *Corynebacterium diptheriae*
4b. Bacterium does not have spores . . . . *Bacillus anthracis*

YOUR JOB: CLEAN THE KITCHEN!

You are responsible for cleaning the kitchen counter after your parents cook dinner. You want to be sure that you kill the most bacteria possible. You aren't sure what product to use to clean the counter. You conduct an experiment, testing 5 different cleaners. You apply the cleaners to five different cultures of bacteria from the counter. You count the number of live bacteria at different times. The results are given in the table below. **Which cleaner should you use?**

Product	Number of live bacteria		
	1 min	5 min	30 min
Lysol	25	15	7
Soapy water	50	25	20
Pinesol	28	14	9
Osyl	20	7	5

ANSWER: You should use Osyl. Osyl killed the most bacteria. It also killed the bacteria the fastest. Lysol was almost as good as Osyl, but it did not kill the bacteria as fast.

*Many disinfectants kill a wide range of bacteria and cells. Not all disinfectants should be used to clean cuts on living things. Why?
Answer: The disinfectant could kill the cells of the living thing. For instance, some disinfectants kill blood cells. If you apply the disinfectant to a cut, it will kill your blood cells as well as the bacteria.

HOW DID THEY GET THERE?

1. One way bacteria cause disease is by growing inside your body. List some ways bacteria could enter your body.

Answers:

breathed in
through a cut or wound
in your food
through an animal bite (like a mosquito or dog)

2. a) Why do surgeons wear masks? **ANSWER: They wear masks so they won't breathe on the patient.**

   b) What part of the face do they cover? **ANSWER: The mask covers the nose and mouth.**

   c) Who is being protected? **ANSWER: The patient is being protected. The patient's body is open and it could get infected very easily. The surgeon does not want to breathe bacteria onto the patient's exposed body.**

WHY?

1. Some bacteria have a very large, thick, sticky carbohydrate layer that surrounds the cell membrane. This is called a capsule. How could a capsule help the bacteria?

Answer: The capsule helps the bacteria in two ways. It makes the bacteria very big, so it is harder for other organisms to eat the bacteria. Also, the sticky capsule can help the bacteria stick to rocks and other things so that it is not carried away by water.

2. Salt was often added to meat before refrigerators were invented to keep food from spoiling. Bacteria usually cannot grow on very salty or very sweet foods. Why do you think this is?

   Hint: Bacteria cannot grow on dry food, such as cereal, either.

Answer: Salty or sweet food limits the water available to the bacteria. Remember that osmosis moves water from areas of low concentration of dissolved substances to areas of high concentration of dissolved substances. Salt and sugar are dissolved substances. Therefore, the salty/sweet food has a high concentration of dissolved substances. Water leaves the bacteria and goes into the food. If the bacteria cannot get water, it cannot live.

3. Some bacteria, called **psychrophiles**, can live and grow only at very low temperatures.

   a) Do you think these bacteria can grow in food in the refrigerator and freezer? **ANSWER: Yes, they can.**

   b) If so, why don't they cause disease in humans when we eat food with psychrophiles growing in it? **ANSWER: Because the temperature inside our bodies is too high for the psychrophiles to grow. Most bacterial diseases are caused by the bacteria growing inside the body. So even if the bacteria grows in the food, it will be killed when the food is cooked or when the bacteria get inside the body.**

   Hint Questions:

   c) What are the primary ways bacteria cause disease?

   d) Compare the temperature of a refrigerator to the temperature inside the human body.

THE DIGESTIVE SYSTEM

THE DIGESTIVE SYSTEM

All living things need energy. Plants can make their own energy from sunlight, but animals must get their energy by eating. A group of organs called the ***digestive system*** in the animal's body changes the foodinto small molecules that its body can use as energy. This process is called ***digestion***.

Digestion requires both physical and chemical changes in the food we eat. These changes start in the ***mouth***, where the food is broken into small pieces and mixed with ***saliva***. Then the food goes down the ***esophagus*** to the ***stomach.*** In the stomach the food is mixed with other chemicals until it is mostly liquid. The food leaves the stomach and goes into the ***small intestine***. Most of the digestion occurs in the small intestine. Most of the chemical digestion occurs in the small intestine. Then the digested food moves into the blood stream through the wall of the small intestine. Diffusion allows the ***nutrients*** (useable food molecules) to move from the small intestine into the blood stream. The unused food continues through the digestive system, into the ***large intestine***. This unused food is expelled from the body through the ***anus.***

STEPS IN DIGESTION

Location	**Activity**
1. mouth	**Chewing** grinds food into small pieces. Saliva is mixed with the food. Saliva contains an enzyme that begins to break down carbohydrates.
2. esophagus	**Swallowing** pushes the food into the esophagus. The muscles of the esophagus push the food into the stomach.
3. stomach	The stomach squeezes the food and mixes it with digestive chemicals. The most important chemicals are ***pepsin*** (an enzyme that digests proteins) and ***hydrochloric acid***. When the food leaves the stomach it is mostly liquid.
4. small intestine	Food goes from the stomach to the small intestine. Most digestion occurs here. The food is mixed with chemicals from other organs in the body. The small intestine secretes ***intestinal juice***, which digests carbohydrates and proteins. The ***liver*** provides ***bile***, which breaks fats into small molecules. The ***pancreas*** produces ***pancreatic juice***, which digests fats, carbohydrates, and proteins. (Bile and pancreatic juice enter the intestine through small tubes.) When the mixing and digestion is complete, the food is in a form that can be used by the cells of the body. The digested food molecules diffuse through the ***villi*** of the small intestine into the blood. The blood carries it to the cells.
5. large intestine (colon)	The parts of the food that cannot be digested (like fiber, for example) move into the large intestine. Water is removed from the feces (undigestible food) and returned to the body.
6. rectum	Feces are stored here until they can be eliminated from the body.
7. anus	Feces are pushed out of the body through the anus.

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

small intestine

teeth

eating (ingestion)

SEQUENCING AND IDENTIFICATION

1. Rewrite these body parts in the order food would pass through them in the digestive process. You may refer to the chart on the previous page if you have difficulty.

stomach
mouth
rectum
esophagus
small intestine
anus
large intestine

*(mouth)
(esophagus)
*(stomach)
*(small intestine)
(large intestine)
(rectum)
(anus)

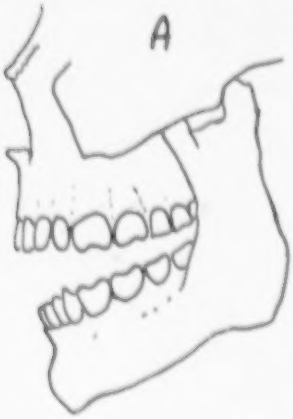
Now go back and place a star next to the structures where some type of digestive enzyme or chemical is found.

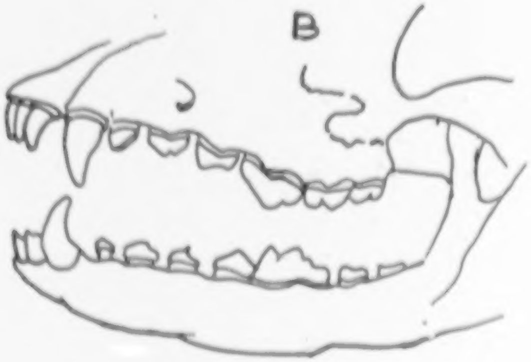
2. Put a check mark by the structures that are accessory organs in digestion (that is, food does not pass through the structure, but the structure is actively involved in digestion).

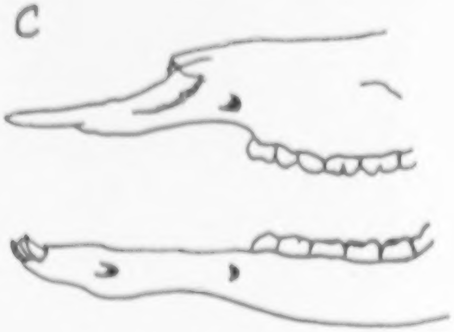
X gall bladder
__ lungs
X liver
X pancreas
__ trachea
X teeth
__ heart
X tongue

MATCHING TEETH WITH FOOD

There are many types of teeth. Some teeth are sharp and are good for tearing meat. Some teeth are thin and flat and are good for scraping. Other teeth are large and square with small bumps that are good for grinding tough food. Look at the pictures of teeth below. Match each picture with the type of food you think the animal with those teeth would eat.







Diets to choose from:

_B__ meat eater

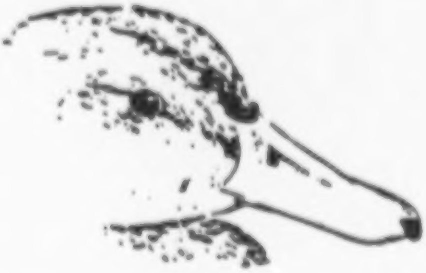
_C_ plant eater

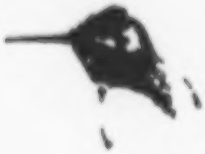
_A_ meat and plant eater

Why did you choose each one?
ANSWER: The meat eater needs sharp teeth to tear apart the animal it eats. The plant eater does not need these sharp teeth. The plant eater needs wide, grinding teeth to chew the plant. The plant and meat eater needs both kinds of teeth.

MATCHING THE FOOD WITH THE BEAK

Look closely at these pictures of bird beaks (pointed mouths). Think about the shape of the beak and how it could be used to capture food. Try to match each beak with the correct method of eating listed at the bottom of the page.


A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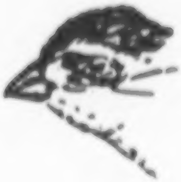
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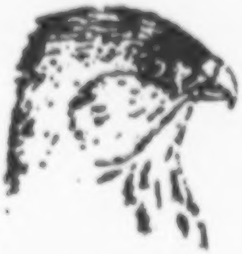

D

_B_ sucks nectar (juice) from flowers

_A_ filters small animals from the water

_D_ tears meat (eats small animals)

_C_ cracks open small seeds

Why did you choose each one?
ANSWER: Bird B, the nectar eater, needs a small, thin beak to put inside the flower. Bird A uses its wide beak to scoop up water and strain out small animals. Bird C uses its short beak to crack open small seeds. Bird D uses the sharp end of its beak to grab small animals.

MODIFYING THE DIGESTIVE SYSTEM

Below are some descriptions of animals with unusual feeding habits. How are their digestive systems differen? Sometimes questions and hints are given to help you start thinking in the right direction. Think about what new organs the animal would need or what organs are not necessary. A description of the animal's actual digestive system is given in your partner's book.

1. A tapeworm is a parasite (an organism that steals nutrients from other oganisms). The tapeworm attaches itself to the intestinal wall of humans. The human intestine contains digested foods that are ready to be absorbed by the human body. How is the digestive of the tapeworm different from the human digestive system?

HINTS:

a) Where does the tapeworm get its food?

ANSWER: The tapeworm's food is the digested food present in the small intestine.

b) How does the food enter the tapeworm's body?

ANSWER: The food enters the tapeworm's cells by diffusion, the same way the digested food enters the human blood stream.

c) What structures of the digestive system does the tapeworm need?

ANSWER: Since the tapeworm is using food that has already been digested, it does not need any of the organs of the digestive system.

d) What structures are unnecessary?

ANSWER: All the structures are unnecessary. For example, the tapeworm does not need a mouth because digested food enters its body by diffusion. The tapeworm does not need a stomach or intestines because it does not have to digest its food (it is already digested). The tapeworm "uses" the human digestive system to digest its food.

2. Snakes eat whole, live animals such as mice. They swallow mice without killing them first. The animal is often larger than the snake's mouth.

a) What would the snake's teeth be used for?

Answer: The snake's teeth are not used for chewing, since food is swallowed whole. The teeth are pointed inward and help to keep the live food from getting out of the mouth.

b) What kinds of things would be included in the undigested food?

Answer: The undigested food would include things like fingernails, hair, bones, etc.

3. A fly often feeds on pieces of solid food which it cannot take into its mouth. It has a sponge type mouth for sucking liquids into its body and for secreting liquids from its body. It does not have teeth.

a) Can the fly take solid food into its body?

Answer: No. It can only such liquids into its body.

b) How could the fly change solid food so that it can be eaten?

Answer: It must change the solid food to a liquid so it can be sucked up through the mouth.

c) How can the sucking mouth help the fly do this?

Answer: The fly spits digestive juices out of its mouth onto the solid food. The digestive juice begins to digest the food, making it liquid. The fly then sucks the partially digested food (now a liquid) through the mouth.

Tutor: If you partner is having trouble, help him/her by asking the hint questions below.

Hint Questions:

d) Does food have to be digested inside the body?

e) What could the fly secrete that would help it change the solid food?

4. A finch (a kind of small bird) has no teeth. The finch feeds mostly on whole, hard seeds. Seeds are difficult to digest whole and need to be broken down. However, it is difficult to break down plant material with chemicals. How should the digestive system be modified to fit this way of feeding?

a) What physical changes in the whole seeds would make them easier to digest?

Answer: The seeds need to be broken up so they can be digested.

b) What structure is the finch missing that it needs?

Answer: Physically breaking food is usually done with teeth. Since the finch does not have teeth, it must have some other organ that grinds the food.

c) Can you invent a structure that would have the same function as the missing structure?

Answer: The finch has a *gizzard*, a muscular organ lined with hard bumps. Food passes through the gizzard before the stomach. The gizzard grinds the food and breaks it up to prepare it for digestion.

5. A deer eats mostly grass and other plants. Grass requires a lot of chewing to prepare it for digestion. A deer has many teeth specially designed for chewing plant material. However, a deer must usually watch out for predators when it is eating because the grass is in open fields where the deer is not protected. Therefore, the deer must eat quickly. Can you invent a digestive system for the deer?

Tutor: If you partner is having trouble, help him/her by asking the questions below.

a) Is there a safer place for the deer to spend time chewing its food?
b) Does food have to be chewed at the time it is eaten?

Answer: Since the deer has teeth, we know that it chews its food. The deer swallows the grass without chewing so that it can eat a lot of grass at once. The grass is stored in a special stomach. Then the deer goes to a safe place. There the deer coughs up the grass and chews it slowly. After chewing, the grass is swallowed again and digested.

6. A starfish feeds on clams. A clam's defense against being eaten is to "clam up" or shut its shells very tightly. However, it is difficult for the clam to remain tightly shut for a long time. Eventually a small opening may appear between the shells. How could the starfish take advantage of the small opening between the clam shells?

Hint Questions:

a) Does food have to be digested inside the body?

Answer: No.

b) Does the digestive system have to stay inside an animal's body?

Answer: No.

c) How could the starfish use the clam shell?

Answer: The starfish uses the clam shell to eat out of!

ANSWER: The starfish sits on top of the clam and waits for the clam shells to open slightly. The starfish has a special stomach that can be put outside the body. When the clam shell opens, the starfish pushes its stomach through the opening. It then digests the clam *inside the clam shell.* After the clam has been digested, the starfish absorbs the nutrients and then pulls its stomach back inside its own body.

NUTRITION

NUTRITION

The food an animal eats must provide certain things to the animal. It must provide energy and certain chemicals that the body needs. It is very important for animals to eat the kind of foods that will provide the things the animal needs. The process of eating foods to help the body is called ***nutrition***.

FOOD ENERGY

A ***Calorie*** is a measure of the energy that a food can supply when it is eaten. Just as we can say that a banana has about 120 grams of weight, we can also say that it has 100 Calories of energy. A Calorie is defined in science as the amount of heat energy that can raise the temperature of 1000 grams of water by 1° Celsius.

All food contains Calories. Our bodies absorb this energy during digestion. If we need the energy for an activity, such as breathing, thinking, growing, talking, or moving, we use it quickly. If we do not need the energy, we store it as fat.

Name	Function	Examples
NUTRIENTS THAT ARE DIGESTED		
Ccarbohydrates (sugars & starches)	provide energy for body cells	fruits, vegetables, grains
Proteins	form hair, nails, ligaments, & muscles	meat, fish, beans, dairy products
Fats	provide energy for body cells; necessary for carrying certain vitamins	red meats, dairy products
NUTRIENTS THAT ARE ABSORBED BUT DO NOT NEED TO BE DIGESTED		
vitamins	Required for proper cell growth and many body functions	Vitamin C, B vitamins
minerals	Required for control and coordination of body functions	calcium, iron, potassium
ENERGY GAINED FROM DIGESTION		
Calories	are a measure of the energy that a food supplies when it is digested. Getting energy is the purpose of digestion.	All foods that can be digested have calories
SUBSTANCE (NOT A NUTRIENT) THAT AIDS IN DIGESTION		
Fiber	stimulates elimination of feces. This keeps undigested food moving quickly through the body.	raw fruits & vegetables, whole grains

Put the following foods into the proper food group. Some foods may go in more than one group.

broccoli
cinnamon
macaroni
pepperoni pizza
milk
shrimp
Cheerios

mangos
cabbage
chicken
chocolate cake
bacon
pineapple
blueberry muffins

mozzarella cheese
pork
rice
toast
bananas
oregano
chocolate chips

MEAT
pepperoni pizza
shrimp
chicken
pork

DAIRY FOODS
milk
mozzarella cheese
pepperoni pizza

BREADS/GRAINS
macaroni
pepperoni pizza
Cheerios
chocolate cake
blueberry muffins
rice
toast

FRUITS & VEGETABLES
broccoli
mangos
cabbage
pineapple
blueberry muffins
bananas
pepperoni pizza

OTHER
cinnamon
bacon
oregano
chocolate chips

What is the OTHER group for? The things in this group have little nutritional value and really do not belong to any of the four major food groups. Many of the foods we eat everyday are included in the OTHER group. These foods really do nothing but provide calories or flavoring. **Bacon is included in the other group. It does not go in the meat group. Even though bacon comes from an animal, it is almost all fat. There is very little meat. Therefore, it is considered part of the OTHER group.**

Below are some recipes. Next to each ingredient, write which food group it would belong to. Also tell whether it is primarily a source of protein, fat, or carbohydrate. After each recipe, tell what food should be eaten with that food to make a complete meal.

FRIED RICE

1/4 cup vegetable oil	OTHER/FAT
3 cups boiled rice	GRAINS/CARBOHYDRATE
1 chopped onion	VEGETABLE/CARBOHYDRATE
3/4 teaspoon salt	OTHER
1/2 cup roast pork cut into squares	MEAT/PROTEIN
3 eggs	MEAT/PROTEIN
1 1/2 tablespoons soy sauce	OTHER
1 cup chopped cabbage	VEGETABLE/CARBOHYDRATE
1/2 cup pea pods	VEGETABLE/CARBOHYDRATE

Heat the oil in a skillet. Add the rice, onion, salt, peas, and meat. Mix well. Make a hole in the center and add the eggs. Scramble the eggs and mix with the rice. Season with soy sauce.

*What could you eat with the fried rice to make it a complete meal? (What food group is missing?) **THE DAIRY GROUP IS MISSING.**

MEXICAN LAYERED DIP

10 corn tortillas, cut in medium pieces	GRAINS/CARBOHYDRATE
1 cup cooked beef	MEAT/PROTEIN
1/2 cup sour cream	DAIRY/CARBOHYDRATE/FAT
1/4 cup taco sauce	OTHER
1 cup guacamole	VEGETABLE/CARBOHYDRATE
1 cup Monterey Jack cheese	DAIRY/FAT
1/2 head chopped lettuce	VEGETABLE/CARBOHYDRATE
2 chopped tomatoes	VEGETABLE/CARBOHYDRATE
1/4 cup sliced jalapenos	VEGETABLE/CARBOHYDRATE

On a plate, layer the beef, guacamole, sour cream, taco sauce, and cheese. Microwave on high for two minutes. Cover with the lettuce, tomatoes, and jalapenos. Serve with tortillas.

*Is this a complete meal? **Yes. All four food groups are present.**

READING NUTRITIONAL INFORMATION ON LABELS

White tuna in oil

Serving size:	2 ounces	% Recommended Daily Allowance (RDA)			
Calories:	120	Ribloflavin	2%	Vitamin B_{12}	20%
Protein	13 g	Niacin	30%	Vitamin B_6	15%
Carbohydrate	0 g	Iron	2%	Vitamin E	6%
Fat	7 g				

Cream of Chicken Soup

Serving size:	8 ounces	% Recommended Daily Allowance (RDA)	
Calories	110	Vitamin A	10%
Protein	3 g	Riboflavin	2%
Carbohydrate	9 g	Calcium	2%
Fat	7 g	Iron	2%

Frozen Green Beans

Serving size:	3 ounces	% Recommended Daily Allowance (RDA)			
Calories	25	Vitamin A	8%	Niacin	2%
Protein	1 g	Vitamin C	15%	Calcium	4%
Carbohydrate	6 g	Thiamine	4%	Iron	4%
Fat	0 g	Riboflavin	4%		

Cheerios (cereal)

Serving size:	1 ounce	% Recommended Daily Allowance (RDA)			
Calories	110	Vitamin A	25%	Calcium	4%
Protein	4 g	Vitamin C	25%	Iron	45%
Carbohydrate	20 g	Thiamine	25%	Vitamin D	10%
Fat	2 g	Riboflavin	25%	Vitamin B_6	25%
		Niacin	25%	Vitamin B_{12}	25%

1. Which of the foods above contains the most protein per ounce?
   A. Cheerios
   B. White tuna in oil
   C. Cream of chicken soup

2. Arrange the four foods in order of fat content per ounce. Put the food with the highest fat content first.
   A. Cream of chicken soup, White tuna in oil, Cheerios, Frozen green beans
   B. White tuna in oil, Cream of chicken soup, Cheerios, Frozen green beans
   C. White tuna in oil, Cheerios, Cream of chicken soup, Frozen green beans

The answer is C. Be sure to compare fat content *per ounce*, not *per serving*.

3. Which of the following foods would have the highest percentage RDA of Riboflavin in a 4 ounce serving?
   A. Frozen green beans
   B. White tuna in oil
   C. Cream of chicken soup

4. Which of the following foods has the most carbohydrate per serving?
   A. Frozen green beans
   B. White tuna in oil
   C. Cream of chicken soup

The answer is C. Be sure to compare carbohydrate content *per serving*, not *per ounce*. Green beans have more carbohydrate*per ounce*, but the serving size is smaller.

5. Why do the serving sizes differ?

Answer: Serving sizes are picked by the person who makes the food. They can make the serving size whatever they want. Usually, the serving size represents how much of that food one person would eat at one meal. So the serving size would be different for different foods.

6. Why do you think the vitamin and mineral information is given in percents?

Answer: You need a different amount of each vitamin. It is easier to know if you are getting enough of a vitamin or if the food is a good source of the vitamin if the amount is given as a percentage of how much you need in a day, rather than in milligrams or some other unit.

EVALUATING A MEAL

For good nutrition, a meal should include something from all four food groups. It is also important to have a good mix of protein, carbohydrates, and fat. The recommended mix is 15% protein, 55% carbohydrates, and 30% fat. Read the three menus below. Decide which one is the best nutritionally. Answer the questions which follow the menus.

	Calories	Protein	Fat	Carbohydrate
A. Hamburger				
—meat	245	21 g	17 g	0 g
—bun	140	4 g	2 g	26 g
French fries	155	2 g	7 g	20 g
Milk	160	9 g	9 g	12 g
B. Baked Ham	245	18 g	21 g	0 g
Mashed potatoes	125	4 g	1 g	25 g
with butter	35	0 g	4 g	0 g
Green beans	30	2 g	7 g	10 g
Apple pie	350	3 g	15 g	51 g
with ice cream	95	2 g	5 g	10 g
C. Bologna sandwich				
—meat	135	11 g	10 g	0 g
—bread	140	4 g	2 g	26 g
Potato chips	115	1 g	8 g	10 g
Pickle	10	1 g	0 g	1 g
Coca-cola	145	0 g	0 g	37 g

1. Which meal is the most nutritious?
   Answer: B

2. Which meal provides the most calories?
   Answer: B

3. Does meal A need anything to make it nutritionally complete? If it does, what would you add?
   Yes. It needs a fruit or vegetable.

THE CIRCULATORY SYSTEM

CIRCULATION

Many different substances need to be moved from place to place inside your body. Nutrients must be delivered to body cells so that the cells can grow and reproduce. Wastes created by the cells must be removed before they can damage the body. Chemicals produced in one part of the body (such as hormones) must be transported to the parts of the body that can use them. Finally, the body's defenses for fighting infection must be able to go to the part of the body that needs help.

Your blood does all of these things. Blood delivers nutrients to the cells, takes wastes away from the cells, transports chemicals, and fights infection. The ***circulatory system*** (the heart and the blood pathways) is the transportation system of the body.

HOW THE HEART CIRCULATES BLOOD THROUGH THE BODY

Look at the pictures of the heart in your book.

1. The ***left atrium*** (upper chamber) of the heart receives blood from the lungs. This blood carries lots of oxygen.

2. The left atrium squeezes together. This pumps the blood into the ***left ventricle*** (lower chamber).

3. The ***valve*** between the two chambers closes.

4. The left ventricle squeezes together. Because the valve between the two chambers has closed, the blood cannot go back into the left atrium. Instead, it goes into the ***aorta*** (the body's main artery).

5. Blood vessels that carry blood away from the heart are called ***arteries***. The aorta branches into smaller arteries, which then branch into even smaller ones. The very smallest branches are called ***capillaries***. The blood finally reaches the capillaries.

6. The blood in the capillaries exchanges products with nearby cells. Nutrients, oxygen, and chemicals from the blood diffuse into the cells; waste substances and cell products (such as hormones) diffuse from the cells into the blood.

7. The blood begins its return trip to the heart. Blood vessels that carry blood toward the heart are called ***veins***. Blood flows into the smallest veins, which begin to join each other to create larger and larger veins.

8. The two largest veins return the blood to the ***right atrium*** of the heart.

9. The right atrium squeezes together. This pumps the blood into the ***right ventricle.***

10. The valve between the two chambers closes.

11. The right ventricle squeezes together. Because the valve between the two chambers has closed, the blood cannot go back into the right atrium. Instead, it goes into the ***pulmonary artery*** (a large artery that leads to the lungs).

12. In the lungs, the blood exchanges the carbon dioxide it got from the cells (a waste substance) for the fresh oxygen breathed in by the lungs. (The carbon dioxide is breathed out by the lungs).

13. The blood, which now carries a lot of oxygen, goes into the ***pulmonary vein*** (a vein that leads from the lungs to the heart). Blood from the pulmonary vein flows into the left atrium of the heart, and the process starts over.

SEQUENCE AND IDENTIFY

Rewrite these structures in the order blood would go through them. Start with the right atrium.

right atrium
left atrium
lungs
right ventricle
pulmonary artery
arteries to the body
pulmonary vein
veins from the body
left ventricle
aorta
capillaries in the body

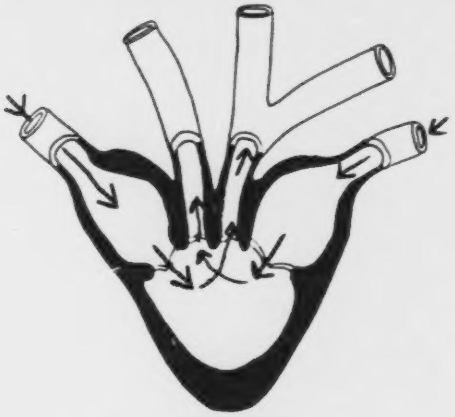
1. right atrium
2. right ventricle
3. pulmonary artery
*4. lungs
*5. pulmonary vein
*6. left atrium
*7. left ventricle
*8. aorta
*9. arteries to the body
10. capillaries in the body
11. veins from the body

Now go back over your list and place a star (*) next to the structures that contain blood with a high oxygen content.

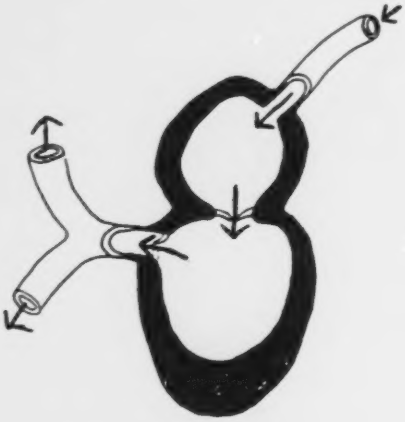
DIFFERENT HEART STRUCTURES

Only mammals and birds have a heart with four chambers (2 atriums and 2 ventricles). Lower vertebrates may have 3 or 2 chambers. Frogs and snakes have 3-chambered hearts — left and right atriums and 1 ventricle. Fish have 2-chambered hearts — 1 atrium and 1 ventricle.

Trace the flow of blood through the 3-chambered heart and the 2-chambered heart below. Indicate where the blood has a high oxygen content and where it has a low oxygen content.



3-chambered heart



2-chambered heart

1. What is the advantage in a 4-chambered heart? How is it more efficient?

Answer: A 4-chambered heart keeps oxygenated and deoxygenated blood separate. Also, blood is pumped twice, so it has a higher pressure.

2. How is a 3-chambered heart more efficient than a 2-chambered heart? In what way is it less efficient?

Answer: A 3-chambered heart pumps the blood twice, thus giving more pressure in the arteries than a 2-chambered heart. However, a 3-chambered heart allows oxygenated and deoxygenated blood to mix. A 2-chambered heart does not (blood does not return to the heart after picking up oxygen).

3. What do you think happens in the ventricle of the 3-chambered heart?

Answer: The oxygenated and deoxygenated blood may mix.

DIFFERENT CIRCULATORY SYSTEMS

The circulatory system of humans is called a **closed system**. Some other animals have an **"open" circulatory system**.

1. Can you guess what the difference in closed and open systems is?

Answer: A closed system keeps the blood in closed vessels at all times. An open system allows blood to flow in open sinuses or cavities. For example, insects have open circulatory systems.

2. What feature of our circulatory system would make it "closed"?

Answer: Our circulatory system has a closed network of veins, arteries, and capillaries that keep the blood in the circulatory system.

3. Is there an advantage in a closed system?

Answer: A closed system is more efficient. Blood is moved more quickly. A closed system is more precise; it makes sure blood goes to all the proper places quickly.

BLOOD PRESSURE

Blood pressure is a measure of the force with which blood moves through blood vessels. If blood pressure is too high, blood vessels and body organs can be damaged. If the blood pressure is too low, blood may not reach all the parts of the body. The force that the heart exerts while pumping the blood is one factor that affects blood pressure. Other factors can also affect blood pressure. Answer the questions below about blood pressure.

1. How would the size of the blood vessel affect blood pressure? (What would happen if the blood vessels were smaller in diameter? What would happen if they were larger in diameter?

Answer: The larger the blood vessels, the lower the blood pressure, since the blood has a larger area to move in. The smaller the vessels, the higher the blood pressure because the blood is moving in a smaller area.

2. If the blood is made thinner, would blood pressure be lower or higher?

Answer: If blood is made thinner, it lowers the blood pressure. It takes less force to move a thin liquid.

3. Sometimes blood pressure is so low, all the blood cannot make it back up the veins in the legs. What would happen to the person?

Answer: The person's legs would swell and the veins would become very visible through the legs because of all the blood that is piling up in the veins. The legs also would not get as much oxygen or nutrients as they need.

COMPONENTS OF BLOOD

Name	Form	Function
plasma	liquid	Carries the solid blood cells through the body; also contains dissolved nutrients
red blood cells	solid	Carries oxygen through the body and takes away carbon dioxide. Red blood cells contain ***hemoglobin***, a substance that oxygen is attracted to.
white blood cells	solid	Fights infection by attacking bacteria and and other substances that shouldn't be in the body (foreign substances)
platelets	solid cell fragments	If vessels have been cut, platelets link together to form a net across the opening. The net catches blood cells and stops the bleeding. This is called ***clotting***.

FUNCTIONS OF BLOOD COMPONENTS

Answer the questions below about the blood and blood components.

1. Small cuts in the skin usually stop bleeding after a short time. The blood clots. What blood component is responsible? **platelets**

2. As the blood passes through the lungs, oxygen combines chemically with something in the blood. What blood component is involved?
   red blood cells
   What chemical in that component does oxygen combine with?
   hemoglobin

3. As the blood passes by the small intestine, digested particles diffuse into the blood. In what blood component are the nutrients dissolved?
   plasma

4. When bacteria infect the body, cells in the blood fight the infection by killing the bacteria. What blood component is responsible?
   white blood cells

5. A hemophiliac is a person who cannot stop bleeding when they are cut. What process in the blood is not working properly in a hemophiliac?
   blood clotting

6. When organs are transplanted into sick people to replace an organ that is no longer working, drugs that suppress the body's reaction to foreign substances are given. Why? **So the white blood cells will not attack the new organ. The body would recognize the new organ as foreign material.**
   What blood component makes these drugs necessary? **white blood cells**

GUESSING THE CONCEPT

For each category shown below, all the things in the Yes column share a certain characteristic. The things in the No column do not have this characteristic. Compare the two columns and tell what characteristic the things in the Yes column share. (Hint: When you have a guess, check the items in the No column. If any of these items have the characteristic you guessed, your guess must be wrong.)

1. YES	NO
left atrium	pulmonary artery
left ventricle	right atrium
aorta	right ventricle
pulmonary vein	veins from the feet

Answer: All the items in the yes column carry highly oxygenated blood.

2. YES	NO
red blood cells	plasma
white blood cells	lymph
platelets	water

Answer: All the items in the YES column are solid components of blood. (All the items, yes and no, are components of blood.)

3. YES	NO
nutrients	bile
oxygen	hair
carbon dioxide	hydrochloric acid
platelets	lymph
waste products	nitrogen
hormones	

Answer: All the items in the YES column may be carried by or found in the blood.

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

heart

capillary

blood clot

THE RESPIRATORY SYSTEM

RESPIRATION

Cells in the body use oxygen in a complex chemical reaction. This reaction lets the body get energy from digested food. This chemical process is called ***respiration***. The human body does not produce oxygen or store it, so the oxygen must constantly be brought into the body from outside. When oxygen is used in this chemical reaction, carbon dioxide and water are created. The body cannot use the carbon dioxide. The body must remove it. The process of ***breathing*** is the way that the body brings oxygen in and takes carbon dioxide out. The ***respiratory system*** is the structures that are involved in breathing.

THE PATH OF AIR IN THE RESPIRATORY SYSTEM

1. Air is ***inhaled*** (breathed into the body) through the nose. The nose warms, cleans, and moistens the air.

2. The air moves through the ***pharynx***, ***larynx*** (voice box), and the ***trachea*** (the windpipe). The trachea divides into two tubes called the ***bronchial tubes***.

3. The air moves through the bronchial tubes to the ***lungs***. Inside the lungs, the bronchial tubes divide into smaller and smaller branches called ***bronchioles.***

4. The air moves through the bronchioles. At the ends of the smallest bronchioles are air sacs called ***alveoli***. Each alveoli is surrounded by capillaries.

5. Air moves into the alveoli. Oxygen from the air diffuses through the capillaries into the blood. Oxygen combines with ***hemoglobin*** in the red blood cells to form ***oxyhemoglobin***.

6. Carbon dioxide from the blood diffuses through the capillaries into the alveoli.

7. The carbon dioxide is ***exhaled*** (breathed out of the body) by the lungs (through the series of tubes described above) through the nose.

8. The blood carries the oxygen to body cells, where it diffuses into the cells. The carbon dioxide in the body cells diffuses into the blood.

SEQUENCE AND IDENTIFY

Rewrite the following structures in the order in which air (oxygen) passes through them when entering the body.

alveoli
nose
trachea
bronchial tubes
pharynx
bronchioles
blood
larynx

NOSE
PHARYNX
LARYNX
TRACHEA
***BRONCHIAL TUBES**
***BRONCHIOLES**
***ALVEOLI**
BLOOD

Now go back through your list of structures. Place a star (*) next to the structures which are part of the lungs.

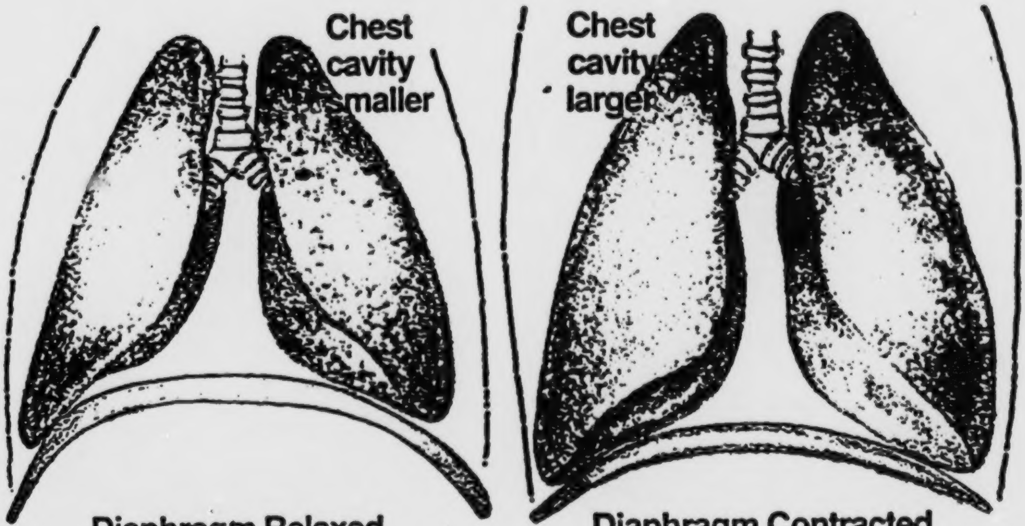
STEPS IN BREATHING

1. The muscles in the rib cage contract to expand the rib cage. The ***diaphragm***, a muscle underneath the lungs, contracts. These two things together increase the space around the lungs.

2. The ***lungs*** are elastic (they can stretch and get smaller). When the space around the lungs increases, the lungs expand to fill the extra space. Air rushes into the lungs because of the extra room inside. This is ***Inhaling***.

3. The diaphragm and the muscles in the rib cage relax. This reduces the space for the lungs.

4. The lungs return to their normal size. The extra air in the lungs is pushed out. This is ***exhaling***.



Diaphragm Relaxed

Diaphragm Contracted

QUESTIONS ON BREATHING

Answer the following questions.

1. Which has the *highest* concentration of oxygen?
   [✓ A.] inhaled air
   B. exhaled air

2. When the diaphragm relaxes, air is
   A. inhaled
   [✓ B.] exhaled

3. What causes air to be inhaled into the lungs?
   [✓ A.] the diaphragm contracts
   B. the diaphragm relaxes
   C. the lungs contract

4. If the diaphragm were suddenly disabled, would your last breath be inhaling or exhaling? Why?

ANSWER: Your last breath would be exhaling, because exhaling is caused by the *relaxing* of the diaphragm. If the diaphragm could not work, you could not inhale.

5. After you exhale, can you force more air out of the lungs? Why? What does this tell you about exhaling?

ANSWER: Yes, you can force more air out because exhaling does not completely squeeze the lungs. Normal exhaling cannot remove all the air from the lungs. You can apply extra pressure to the lungs to force more air out.

6. Artificial respiration is a life-saving skill. In artificial respiration, you place your mouth over the mouth of someone who has stopped breathing and exhale into their mouth, forcing the air into their lungs. Since the air you are forcing into their lungs is the air you were exhaling, how does it help the person? Does it contain oxygen?

ANSWER: The air you exhale *does* contain oxygen. About 16% of the exhaled air is oxygen. The exchange of oxygen and carbon dioxide in the lungs is not perfect. Thus, when you perform artificial respiration, you are breathing oxygen into the other person's lungs.

PICTURE WORDS

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alveoli

inhaling

nose hairs

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

			COMMON FEATURE
1.	pharynx [✓ esophagus]	trachea bronchiole	**They are part of the respiratory tract**
2.	rib cage diaphragm	[✓ bronchial tubes] lungs	**They change size when you breath**
3.	[✓ heart] lungs	gills skin	**They are organs that can be used to get oxygen**
4.	diaphragm relaxes rib muscles relax	you can talk [✓ oxygen binds to hemoglobin]	**These happen when you exhale**
5.	clean moisten	[✓ extract oxygen] warm	**These are functions of the nose**

HOW AQUATIC ANIMALS BREATHE

1. Below is a picture of a ***gill***, the respiratory organ found in most kinds of fish. The gills are found on both sides of the fish, near the head. They are exposed to the water, with a small flap of scales covering them. Water flows over the gill. Oxygen diffuses from the water into the circulatory system.

   a) Do fish breathe?

   Answer: YES

   b) Where do they get oxygen?

   Answer: From the water. (The oxygen is taken out of the water at the gills.)

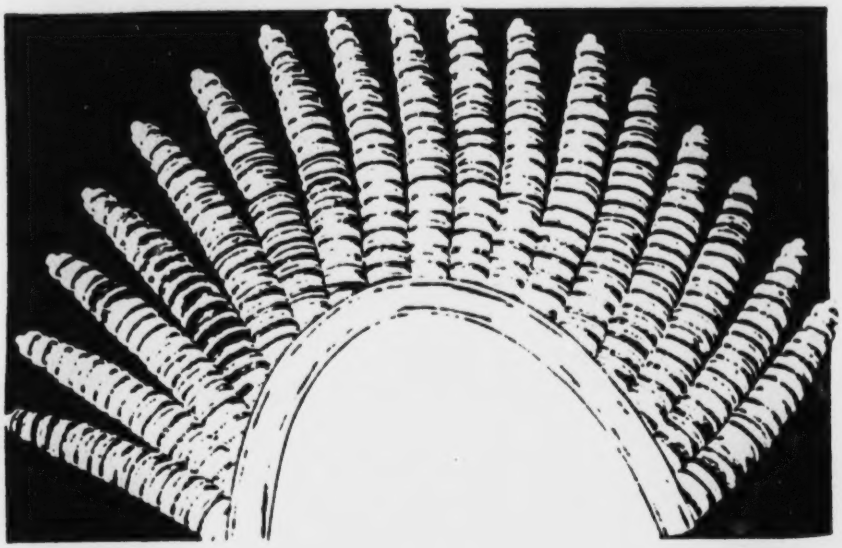
   c) Why can't animals with lungs get oxygen from the water? (Hint: Think about how air gets in and out of the lungs. What would happen if water were coming in instead of air?) **Answer: Water is too heavy for the lungs to exhale simply by relaxing muscles. The water saturates lungs and makes it impossible to exhale.**

2. Circle the area of the gill where you think the most oxygen is picked up. What part of the lungs is this like? **Answer: This area is similar to the alveoli, the smallest parts of the lung.**

3. Many fish do not actively pump water through their gills like humans pull air into the lungs. How could the fish move water over the gills? **Answer: The fish force water over the gills by swimming.**

   If these fish are unable to move in the water, it will die. What does it die of?

   Answer: It suffocates from lack of oxygen. Since it cannot move, it cannot get water to the gills.



THE ROLE OF THE NOSE

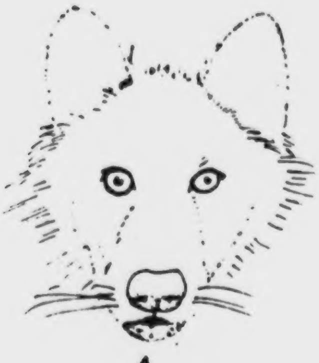
The nose has three important functions: 1) to warm the air that enters the respiratory system, 2) to moisten the air that enters the respiratory system, and 3) to clean the air that enters the respiratory system. Many capillaries in the nose help the nostrils warm the air. The inside of the nose is lined with mucous and tiny hairs.

1. How do the mucous and hairs help the nose perform the other two functions?

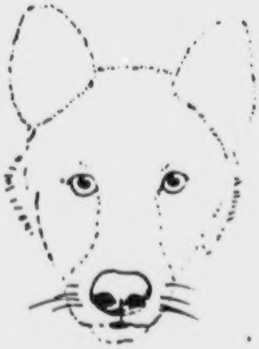
ANSWER: The mucous adds moisture to the air. It also traps foreign particles in the air. The nose hairs help to trap dust and other particles in the air.

2. These are two different species of wolves. One wolf lives in Florida, a warm, wet place. The other wolf lives in Alaska, a cold, dry place. Look at the noses of the wolves. Can you tell from the noses which wolf lives in Alaska and which lives in Florida? Explain your answer. (Hint: Think about the functions of the nose.)

Answer: Wolf A lives in Alaska and Wolf B lives in Florida. The nose of the wolf that lives in the cold, dry environment has a lot of work to do to warm and moisten the air. Therefore, the Alaskan wolf has smaller nostrils so only a little air can come in at a time. The wolf that lives in Florida breathes warm, moist air. Thus its nose has less work to do. It can take in more air at a time.



A



B

ACHOO!!

Jim has a cold. He keeps sneezing. His nose is stuffed up. He coughs almost as much as he sneezes.

Maria wants to play a joke on her teacher. She sprinkles pepper all over a flower and then has her teacher, Mr. Kenny, smell the flower. The teacher begins to sneeze uncontrollably.

The respiratory system is responsible for both of the situations above.

1. Why do people sneeze?
Answer: People sneeze to get rid of unwanted particles in the nose.

2. What is making Jim's nose stuffy? **Jim's nose is full of extra mucous. The mucous is full of bacteria that cause the cold.** Why do people cough? **Coughing clears the throat of any particles that may be present.**

3. Why did Mr. Kenny sneeze when he smelled the pepper?
Answer: The pepper made the air Mr. Kenny breathed unclean. The nose was irritated by the pepper. Mr. Kenny sneezed to get rid of the dirty air.

4. How are these two situations (Jim and Mr. Kenny) similar?
Answer: Both these situations involve the nose cleaning the air that enters the respiratory system.

5. What function of the nose is involved?
Answer: Cleaning the air

6. Sometimes when your nose is stuffed up, you breathe through your mouth. This usually makes your throat dry and sore. Why? What does the nose do that the mouth cannot do?
Answer: If you breathe through your mouth, your nose cannot perform its functions of warming and moistening the air. Thus your throat is exposed to cold, dry air. This irritates your throat.

DIAGNOSING MEDICAL PROBLEMS

1. When gasoline or other fuels are burned, carbon monoxide is formed. Carbon monoxide and hemoglobin are attracted to each other very much. Hemoglobin is more attracted to carbon monoxide than it is to oxygen.
a) What would happen if you worked on a car with the garage door closed and the engine running?

ANSWER: Your car is producing carbon monoxide, since it is burning gasoline. You would breathe the carbon monoxide. The hemoglobin in your blood would pick up carbon monoxide instead of oxygen. You would suffocate.

b) What would happen to your cells if you breathed carbon monoxide? Why? **ANSWER: Your blood cells prefer carbon monoxide over oxygen. Therefore, carbon monoxide would be picked up and transported to the body cells. The body cells cannot use carbon monoxide. Since the cells would not be getting oxygen, they would die.**

2. Smoking tobacco is bad for your lungs. Chemicals in tobacco make your lungs less elastic. How would this affect breathing? (Think about how your lungs change during breathing.) **ANSWER: If your lungs were not elastic, they would not expand and retract when you inhaled and exhaled. Exhaling would be especially difficult. You would have too much air left in the lungs after you exhaled.**

Smoking also produces chemicals which destroy the walls of the alveoli. How would this affect gas exchange in the lungs? **ANSWER: Without the alveoli, there is not much surface area for oxygen and carbon dioxide to be exchanged. Your blood would not get very much oxygen and it could not get rid of all its carbon dioxide.**

3. Asthma is a disease that affects the respiratory system. When a person has an asthma attack, it becomes very difficult to breathe. Often, the throat makes a "wheezing" or "whistling" sound during breathing. What is causing the difficulty in breathing? What is causing the sound? **ANSWER: During an asthma attack, the bronchial tubes or trachea become smaller and allow only a small amount of air to pass into and out of the lungs.**
(**Hint:** Put your mouth in the shape to say "Ah". Blow air out through your mouth. Do you hear a sound? Now whistle. How did you change the shape of your mouth to make the whistle sound? What structure used in breathing is producing the wheezing during an asthma attack?)

MODIFYING THE RESPIRATORY SYSTEM

1. A whale is a very large mammal that lives completely in the water. A whale has lungs and does not have gills. How is the whale's respiratory system different from the human respiratory system?

   a) Can the whale get oxygen from the water?

ANSWER: No. An animal must have gills to get oxygen from the water.

   b) How could the whale get air?

ANSWER: The whale comes to the surface of the water and puts the top of the head into the air. The whale has a hole on the top of the head similar to our nose. The whale breathes through this hole.

   c) Do you think the whale breathes as often as other mammals?

ANSWER: No. The whale does not breathe as often. If it did, it would have to swim with its breathing hole out of the water most of the time.

   d) If the whale doesn't breathe as often, how can it supply its cells with enough oxygen?

ANSWER: Since the whale sometimes needs to stay under water for long periods of time, it has large "storage units" to hold oxygen so that it does not need to breathe as often as other mammals.

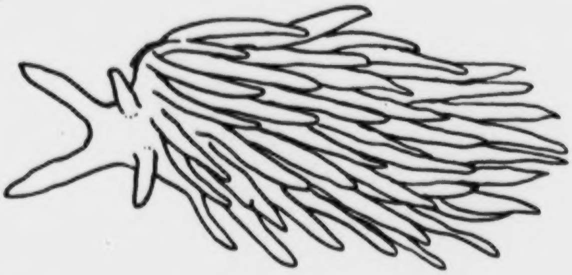
2. This animal is a nudibranch. It is a very small animal, about the size of a small insect. It lives in the ocean. The nudibranch does not have a respiratory system. Can you guess how it gets oxygen into its cells and carbon dioxide out?

   a) What process allows cells to exchange substances?

ANSWER: Diffusion

   b) How would the shape of the nudibranch's body help make this process more efficient?

ANSWER: The nudibranch exchanges oxygen and carbon dioxide by diffusion. It gets oxygen directly from the water and expels carbon dioxide directly into the water. The long projections on the nudibranch's body give it a lot of surface area. This makes diffusion much easier and more efficient.



THE EXCRETORY SYSTEM

EXCRETION

Substances that the cells of the body cannot use are called ***wastes.*** Many of the wastes found in the body are produced as the body goes about its normal functions. For example, ***ammonia*** is a waste product produced as the body digests proteins. Ammonia is poisonous to cells. Your body must remove the ammonia from the cells before it begins to kill the body cells. (Ammonia is changed into ***uric acid***, a non-poisonous chemical, in the body, so that it can be stored and removed from the body periodically.)

Not all wastes are poisonous like ammonia. Some wastes are merely excess amounts of things that your body normally uses. For example, if your body has more water than it needs, the excess water is called waste. If these wastes were allowed to accummulate in the body, there would eventually be so much waste that there would not be any room for functioning cells.

The ***excretory system*** removes wastes from the body before they can harm functioning cells. The ***kidneys***, the ***lungs*** and the ***skin*** are all excretory organs. Each removes different wastes from the body.

WASTES THAT ARE NORMALLY EXCRETED FROM THE BODY

Type of Waste	How the waste is produced	How the waste is removed from the body
ammonia	result of protein digestion	filtered from blood in kidneys; leaves as urine through the urinary tract
carbon dioxide	produced when cells use digested food for energy	removed from blood in lungs; leaves lungs in exhaled air (see the unit on respiration)
water	produced from normal cell activity and digestion	1) filtered from blood in kidneys; leaves as urine through the urinary tract 2) leaves the body through the skin as sweat
salt	brought into the body through eating; produced through normal cell functioning	1) filtered from the blood in kidneys; leaves as urine through the urinary tract 2) leaves the body through the skin as sweat
some vitamins	brought into the body through eating	filtered from the blood in kidneys; leaves as urine through the urinary tract

HOW THE KIDNEYS FUNCTION

1. As blood travels through the body, it acquires wastes from the body cells.

2. All blood at some time passes through the ***kidneys*** to be cleansed.

3. As the blood passes through, the kidneys filter the wastes and excess water.

4. The wastes are collected in the kidney in the form of ***urine*** (excess water and wastes).

5. Urine leaves the kidneys through small tubes called the ***ureters.***

6. The ureters take the urine to the ***urinary bladder***, where urine is stored until it can be expelled from the body.

7. When the bladder is full, the urine is expelled from the body through a tube called the ***urethra***.

HOW THE LUNGS EXCRETE* CARBON DIOXIDE

(These steps are also found under RESPIRATION)

1. Carbon dioxide in body cells diffuses into the blood.
2. The blood is carried to the capillaries surrounding the alveoli of the lungs. The carbon dioxide diffuses into the alveoli.
3. The carbon dioxide is breathed out of the body through the lungs.

---

*The lungs are excretory organs as well as part of the respiratory system.

IDENTIFICATION

Put a check mark next to all the organs involved in some type of excretion.

_X_ skin

____ liver

_X_ kidneys

_X_ lungs

_X_ urinary bladder

____ pancreas

____ gall bladder

_X_ large intestine

Put a **check** next to the substances that may be excreted from the body as waste. Put an **S** next to those excreted through the **skin**. Put a **U** next to those excreted in **urine**. Put a **B** next to those excreted in your **breath**. Some substances may be excreted in more than one place, and therefore can receive more than one letter.

_S.U_ salt

____ protein **(Protein is a nutrient that is absorbed by cells. It should not be excreted from the body.)**

_S.U_ water

_U_ ammonia

____ sugar **(Sugar is a nutrient that is absorbed by cells. It should not be excreted from the body. If sugar is found in the urine, it can indicate a serious medical problem.**

____ oxygen **(Oxygen is a gas that is carried in the blood. It is brought into the body for use by the cells. It is not excreted.)**

_B_ carbon dioxide

SEQUENCE

Rewrite these structures in the order ammonia passes through them.

kidney
blood
urethra
body cells
ureter
urinary bladder

body cells
blood
kidney
ureter
urinary bladder
urethra

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

kidney

sweating

skin

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

1. skin lungs [✓ pancreas] kidneys
   These are organs of excretion

2. salt vitamins water [✓ sugar]
   These are normally excreted wastes

3. respiratory system [✓ endocrine system] digestive system circulatory system
   These systems are involved in excretion

4. [✓ renal artery] ureter bladder urethra
   These structures collect or pass urine

EXCRETION IN DESERT MAMMALS

Think about the three ways wastes are excreted: in urine, in sweat, and in water droplets in exhaled air. All of these methods use water. This presents a problem for mammals that live in the desert. These animals need to keep as much water as possible, but they also need to get rid of their body wastes. How could the excretory system be modified to accomodate the extremely dry environment of the desert?

1. What type of food should a desert animal avoid eating to reduce the amount of urine produced? What kinds of food should the animal eat instead?
   Hint Questions:
   a) What is the primary waste present in urine? **Answer: The primary waste in urine is uric acid.**
   b) How is this waste product formed? **Answer: Uric acid is formed from ammonia. Ammonia comes from digesting protein. If the animal eats less protein, it will produce less ammonia, and therefore it will produce less urine. The animal should eat foods high in carbohydrates or fat.**

2. The urine of most mammals is about 10% dissolved wastes (minerals, salt).
   a) How do you think the urine of desert mammals is different from most mammals? **Answer: Desert mammals have very concentrated urine.**
   b) How is this an advantage for desert mammals? **Answer: They can excrete more waste in less water. This helps them save water.**

3. The kangaroo rat is a small rodent that lives in the desert. It spends most of the day buried in a hole underground. The opening to the hole is covered with leaves and rocks.
   a) How could this situation help the kangaroo rat save water lost in exhaling? **Answer: Since the opening to the hole is closed, the moisture expelled in the air stays in the hole. The rat can breathe the moist air back in.**
   b) Does it help the rat save water in any other ways? **Answer: By staying underground the rat stays cooler. This helps save water normally lost in the heat.**
   Hint Questions:
   c) Where does the exhaled air (from the kangaroo rat) go?
   d) What happens to the water that was expelled with the air?

EXCRETION IN AQUATIC ANIMALS

Animals that live in the water often have much simpler excretory systems than land animals. In fact, many do not need a "system" at all. Answer the questions below about excretion in aquatic animals.

1. Small animals that live in the water often have no excretory system.
   a) How do they get rid of body wastes? (Hint: Think about how wastes are filtered from human blood in the kidney.) **Answer: Wastes can be excreted directly into the water. The wastes diffuse from the animal's body into the water.**
   b) What keeps the wastes the animal has just released from going back into the animal's body? **Answer: The wastes are carried away from the animal's body by the water.**
   c) Is there an excretory process in humans that is similar to the excretion process in these small aquatic animals? **Answer: This excretory process is similar to the way humans excrete wastes through the skin.**
   Hint Questions:
   d) How do substances normally move in and out of cells?
   e) Could wastes leave the body in this way?

2. Fish have kidneys that function much like a mammal's kidney. However, they mostly function to remove non-poisonous wastes, such as salt and excess water. Ammonia is excreted across the gills (the respiratory structure) directly into the water. Ammonia is not changed to uric acid, as it is in land animals.
   a) Why isn't it necessary for the fish to change ammonia to uric acid? **ANSWER: Since ammonia is excreted quickly, across the gills, it does not need to be changed to uric acid.**
   b) Why isn't ammonia excreted with the other wastes? **Aquatic animals excrete ammonia quickly because it is poisonous. Other wastes are not as dangerous and can be excreted normally.**

   Hint Questions:
   d) Why do land animals change ammonia to uric acid? **Land animals must change ammonia to uric acid because they cannot excrete it quickly.**
   e) Which excretory process is quicker, excreting ammonia into the water or changing it to uric acid and storing it until it can be excreted?

URINE IN MEDICAL ANALYSIS

When doctors are checking on a patient's health or trying to determine what is wrong with someone, they often ask for a sample of the patient's urine. The urine is analyzed to see what substances are in it and how much of each substance there is.

a) What is normally found in urine?

Answer: uric acid, salt, water, vitamins, minerals, and other things.

b) What kinds of things do you think the doctor is looking for?

Answer: The doctor is looking for things that don't belong in urine, such as blood, sugar, proteins, etc. Also, the doctor is looking for the amounts of the normal waste products present.

c) How would information about the contents of the urine help the doctor?

Answer: By analyzing the urine, the doctor can tell if some body systems are working properly. Is the body excreting things it shouldn't? Is the urinary tract bleeding? Is the body excreting too much salt?

d) Can you predict some things that might be in the urine that shouldn't be?

Answer: Sugar, blood, proteins, excessive amounts of vitamins, etc.

THE SKELETAL AND MUSCULAR SYSTEMS

SKELETAL SYSTEM

The network of ***bones*** in the body is called the ***skeleton***. The bones of the skeleton have several important functions. First, bones support the weight of the body. Second, they protect the organs of the body by providing a hard covering for them (for example, the bones in your head protect your brain). Third, the inner part of the bone, the marrow, manufactures red blood cells. Fourth, the bone stores calcium for the body to use. And finally, many of the body's muscles are attached to bones, making it possible for you to move.

Bone has many different parts. The outside of a bone is covered with a thin covering which contains many nerves and small blood vessels to nourish the bone. The ends of bones are sometimes covered with ***cartilage***, a clear, flexible material. The ends of bones are composed of ***spongy bone***. This part of bone is strong, but it contains many empty spaces. Most of the bone is made of ***solid bone***. This is very compact and strong. This is where calcium is stored. The middle of the bone is called the ***bone marrow***. It is very soft. The bone marrow produces blood cells and platelets.

The point where bones meet is called a ***joint.*** There are several types of joints. Each types allows a different type of movement between the bones. For instance, a ***suture*** is a joint between bones in the skull. Sutures do not allow any movement between the skull bones. A ***hinge*** joint connects the bones in the upper arm to the lower arm at the elbow. A hinge allows the bones to move in only two directions, like the hinge on a door.

Ligaments are long fibers which hold bones together. ***Tendons*** are fibers which attach muscles to bones.

MUSCULAR SYSTEM

Muscles are the tissues of the body that cause movement. When you walk, it is the muscles that move and pull the rest of the body with them. When you digest food, it is muscles that move the food through your digestive system. When your heart beats, it is muscles that pump the blood. Muscles move by ***contracting***. Contraction means getting smaller. The parts of the muscle pull closer together, making the muscle smaller. If the muscle is attached to a bone, the bone moves when the muscle gets shorter.

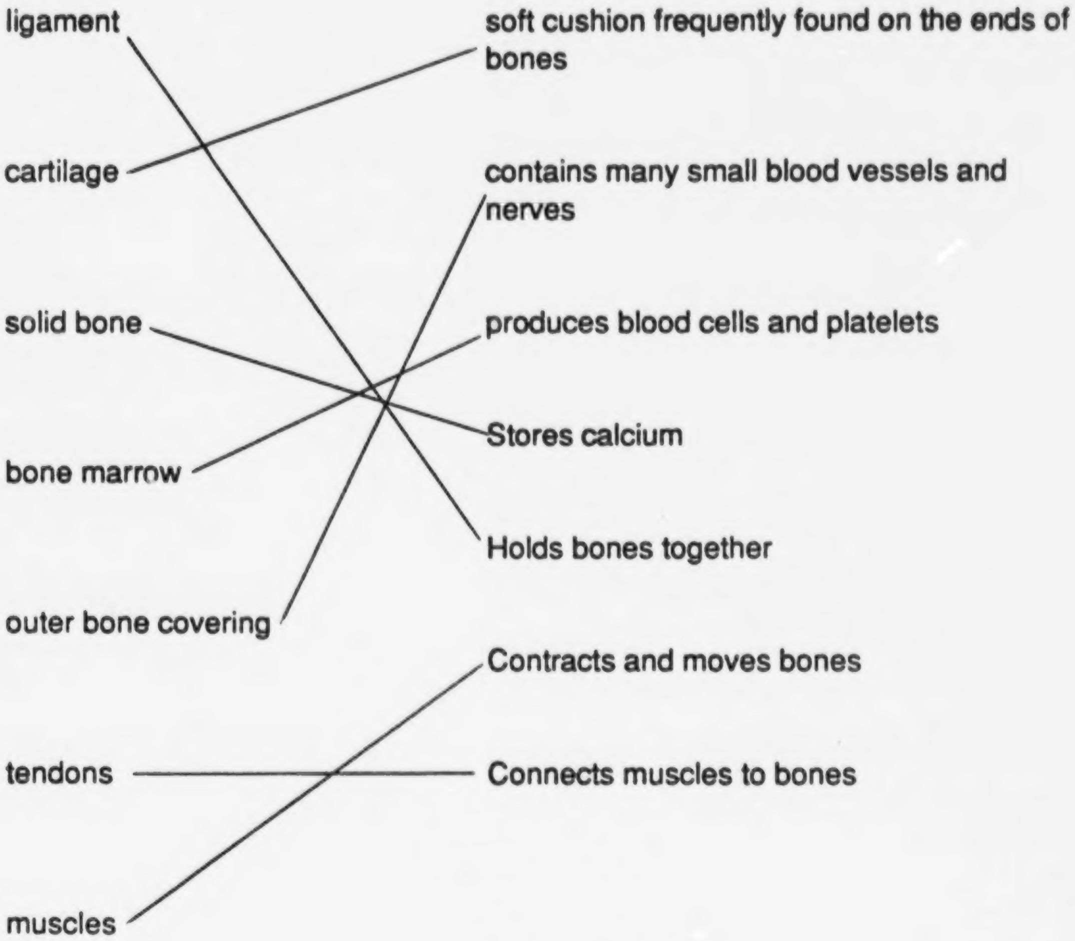
There are three kinds of muscle in the body: skeletal, smooth, and cardiac. ***Skeletal muscles*** (also called voluntary, striped, or striated muscles) are the muscles that you can control. These muscles are attached to bones. Skeletal muscles are grouped into pairs that control opposite movements. For example, one muscle bends your arm and its partner muscle straightens your arm.

Smooth muscles (also called plain, involuntary, and visceral muscle) are muscles that you cannot control. Your stomach muscles automatically squeeze the food that you eat. You do not tell the stomach muscles to move.)

The third type of muscle, ***cardiac muscle***, is only found in the heart. Cardiac muscle is striped like skeletal muscle. However, movement of cardiac muscle is involuntary (you cannot control the way your heart beats).

MATCHING

Draw lines connecting the structures listed on the left with the descriptions or functions listed on the right.



ligament
cartilage
solid bone
bone marrow
outer bone covering
tendons
muscles

soft cushion frequently found on the ends of bones
contains many small blood vessels and nerves
produces blood cells and platelets
Stores calcium
Holds bones together
Contracts and moves bones
Connects muscles to bones

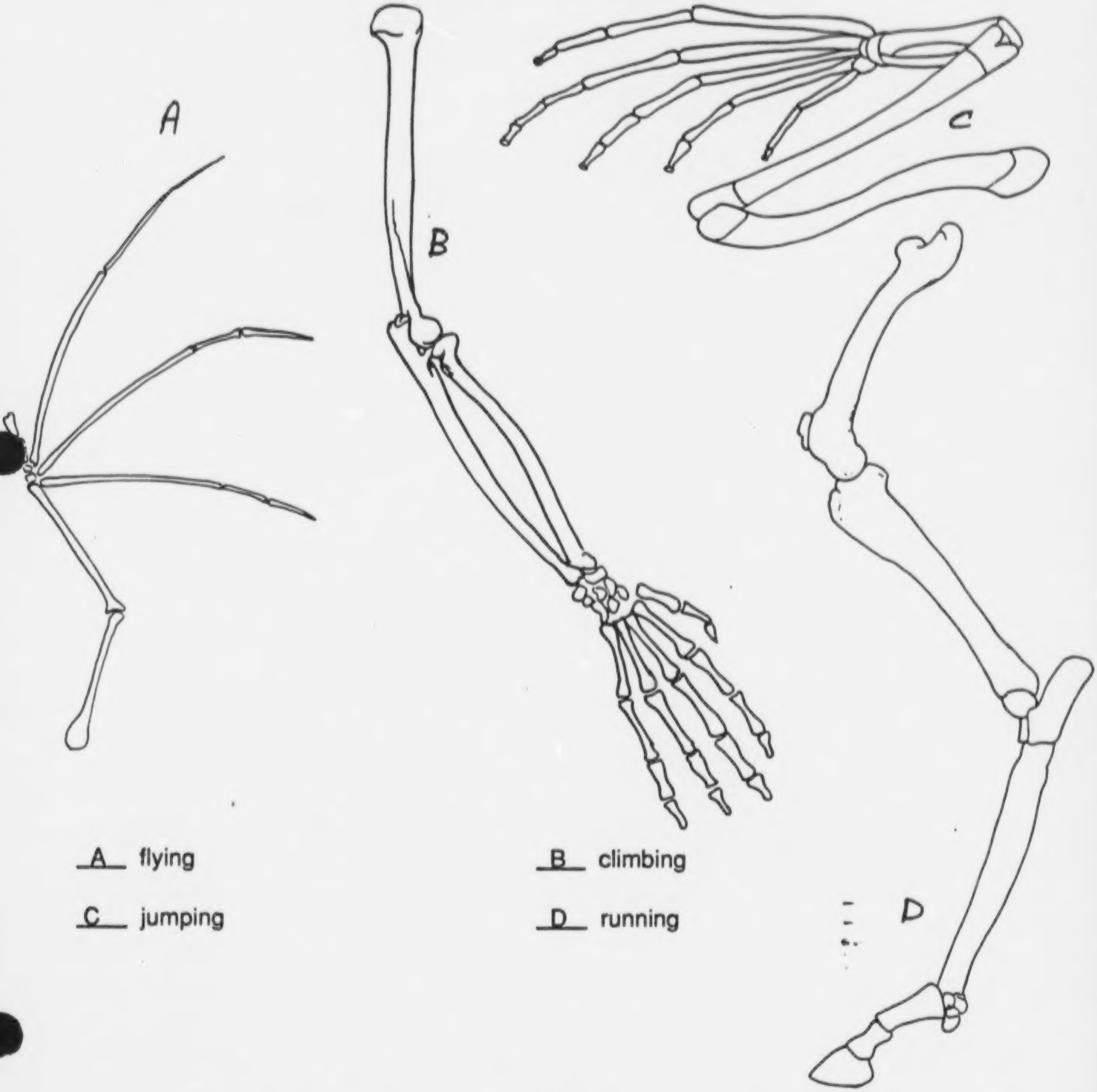
ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

1.	running blinking	swallowing [✓ thinking]	**These all require muscles**
2.	spongy bone [✓ cartilage]	marrow solid bone	**These are all parts of bone**
3.	support protection	muscle attachment [✓ calcium production]	**These are functions of the skeleton. (Calcium is not *produced* by bones. It is *stored* in bones.)**
4.	skull rib cage	pelvis [✓ leg bone]	**These are bones that surround and protect organs**
5.	elbow knee	hip [✓ rib]	**These are joints**
6.	tendons ligaments	[✓ smooth muscle] skeletal muscle	**These are all connected to bone**

MATCHING BONES WITH MOVEMENT

Compare the bone structures of the limbs (arms, legs, wings) drawn below to the activities listed at the bottom of the page. Match each limb with the activity you think it is best suited for. (Think about the shape of the limb and the functions of the bones and how the muscles may be attached.)



A flying

B climbing

C jumping

D running

MATCHING

Match the muscle type on the left with the proper function in the right column.

skeletal	Muscle of the heart. It is under involuntary control.
cardiac	Moves limbs, etc. It is under voluntary control.
smooth	Controls body organs and vessels. It is under involuntary control.

Match the joint types on the left with the proper description in the column on the right.

ball & socket	movement back and forth or up & down
hinge	complete circular or rotary movement
suture	no movement

JOINTS

Test the joints in your body and decide which type they are.

Moveable joint types:
hinge
ball and socket
biaxial (like two hinges put together)

elbow HINGE

knee HINGE

shoulder BALL AND SOCKET

hip (thigh to body joint) BALL AND SOCKET

wrist BIAXIAL

ankle HINGE

finger to hand BALL AND SOCKET

finger knuckles HINGE

thumb to hand BIAXIAL

jaw HINGE

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

tendon

joint

suture

skull

MUSCLES

1. There are many types of muscles. Not all of them are long, like arm and leg muscles are. Some are round. They are called ***sphincter*** muscles. The sphincter muscles open and close tubes or openings. Name the places in your body you might find sphincter muscles.

ANSWER: Sphincters are found in many places. Some of them include around the mouth, between the esophagus and the stomach, between the stomach and the small intestine, and around the eyes.

2. Find the muscles in your body that perform the following movements. Can you feel the muscles work? Can you tell when they are contracting and when they are relaxing?

   chewing
   pointing your foot
   bringing your hand toward your shoulder
   nodding your head
   smiling
   raising your eyebrows

3. Can muscles move if they are not attached to a bone? What types of muscles are not attached to bone?

ANSWER: Yes. Smooth muscle is not attached to bones. Only skeletal muscle needs to be attached to a bone to work.

MEDICAL QUESTIONS

1. You jump out of a tree. When you land, you hear something snap and you feel pain in the lower part of your leg. You have broken one of the bones in your lower leg. The doctor puts a cast (hard covering) on your leg.
   a) Why does the doctor put a cast on your leg? **ANSWER: The cast keeps the bones from moving while they heal.**

   b) What is happening when the bone "heals"? **ANSWER: While healing, the bone actually grows back together at the broken site.**

   c) The cast will keep some joints from moving. Which ones? Why? (Hint: More than one joint will be immobilized). **ANSWER: The joint above the break and the joint below the break must both be immobilized. If the joints could move, it would move the bones and keep them from growing back together.**

2. Someone pulls your arm very hard. You hear a popping sound and feel extreme pain in your shoulder. You can't move your upper arm; it hangs limply from your shoulder. None of your bones are broken.
   a) What part of the skeletal system do you think has been injured? **ANSWER: A joint has been injured.**

   b) What do you think happened? **ANSWER: The shoulder joint has been pulled apart so that the arm bone and the shoulder bone no longer meet.**

   c) How would you fix the problem? **ANSWER: The arm bone must be pushed back into place so that the joint is repaired.**

3. A person whose legs are paralyzed cannot move the muscles of the leg.
   a) What do you think happens to the muscles if they are not exercised?
ANSWER: The muscles become very small and useless if they are not exercised.

   b) What could be done to stop this process? **ANSWER: To stop this, the leg muscles must be manually exercised. The leg is bent and unbent many times to keep the muscle healthy.**

4. When a person is cold, he will often shiver (the body shakes slightly all over).
   a) What must be happening to make the body move? **ANSWER: Muscles must be contracting.**

   b) How does this help heat the body? **ANSWER: The skeletal muscles are contracting slightly and quickly. When muscles contract, they give off heat. Shivering, then, helps to warm the body by producing heat.**

   Hint Questions:
   c) What happens to the temperature of the body when you exercise? **ANSWER: It goes up.**

   d) What, then, is produced when muscles contract? **ANSWER: Heat is produced when muscles contract.**

5. Tetanus is a disease caused by the bacteria *Clostridium tetani*. This bacteria produces a chemical like the one your nerves produced to tell a muscle to contract.
   What effect would this have on a person infected with the bacteria?

ANSWER: The chemical produced by the bacteria causes the muscles it comes in contact with to contract. The person cannot control these muscle contractions. Eventually, many of the muscles in the body become contracted permanently. The person is stuck in strange positions and cannot move. Tetanus eventually causes death.

VARIATIONS

1. When birds fly, they must be able to lift all their weight off the ground and keep it suspended in the air. Birds have very large muscles in their chest, leading to their wings, which enable them to produce enough force to fly.

   a) How could the skeletal system be modified to make flying easier?

ANSWER: The bird skeleton is very light. The bones are not as solid as human bones. This makes it easier for the bird to fly.

   b) How must the bones in the chest change because of the large chest muscles? (Think about the functions of the skeleton.) **ANSWER: The bone in the chest is much larger in birds than in humans. The large chest muscles must have a large bone to attach to.**

   Hint Questions:

   a) Are bones heavy or light?
   b) Would heavy bones help or hurt a flying bird?
   c) What do skeletal muscles need to work?
   d) What size bone does a large muscle need to attach to?

2. Insects have a complex ***exoskeleton*** with many joints. It is not made of living cells. It is made of chemicals that have hardened.

   a) Can an exoskeleton grow like our bones grow? **ANSWER: No, since it is not made of live cells.**

   b) What must happen to the exoskeleton when the rest of the insect grows? **ANSWER: In order to grow, the insect must shed its exoskeleton and then secrete a new exoskeleton to fit the bigger body.**

   c) What are some disadvantages to this type of growth? **ANSWER: This can cause problems because the skeleton is not protecting the insect while the new skeleton is being secreted. The insect can be easily attacked.**

3. Compare an exoskeleton (like insects have) to an endoskeleton (like we have). Decide which one is better for each of the categories listed.

	Exoskeleton	Endoskeleton
Protection	X	
Support		X
Muscle Attachment		X
Growth of Organism		X
Light (not heavy) Skeleton		X
Movement (Flexibility)		X

THE NERVOUS SYSTEM

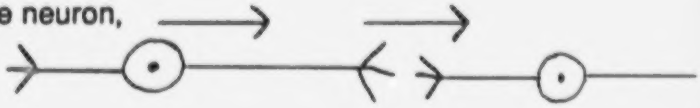
THE NERVOUS SYSTEM

The ***nervous system*** is a control system for the body. It is the message system that directs and coordinates all of the body's activities. The nervous system carries messages between the environment that we live in, the brain, and all the parts of the body.

The ***brain***, the ***spinal cord***, and the network of ***nerves*** that run throughout the body make up the nervous system. The brain and the spinal cord are called the ***central nervous system*** (in the center of the body); the network of nerves is called the ***peripheral nervous system*** (along the edge or outer part of the body).

Messages from one part of the nervous system to another travel along nerves. Nerves are made up of long lines of nerve cells, or ***neurons***. When a message begins to move along a nerve, it starts at the first neuron and moves

1. from the fibers at the short end of the neuron,
2. through the cell body,
3. along the fibers at the long end, and
4. jumps across the synapse (space between neurons)
   to the fibers at the short end of the next neuron.



It is important to see that the two ends of the neuron are different. Impulses that travel through neurons always start at the short end and go to the long end. This means that *impulses may travel in only one direction*. So, a set of neurons may carry impulses from either the body to the brain, or from the brain to the body, but not both.

For this reason, nerves work in pairs. One set of neurons is lined up to carry impulses from your sense organs to your brain. These are called ***sensory neurons***, because they collect information sensed by the body. A second set of neurons is lined up to carry impulses from your brain to your muscles. These are called ***motor neurons***, because they can signal your body to move. There is also a third set of neurons called ***associative neurons***. They are located in the brain and the spinal cord. They allow sensory nerve cells and motor neurons to communicate, or associate, with each other. Associative neurons make it possible for motor neurons to respond correctly to sensory neurons.

Nerves are found throughout your body. Each part of your body has a pathway of nerves to and from the brain. These pathways interconnect, like roads, so that, for example, messages from your fingers may share a nerve pathway after they reach the wrist. Also, one nerve may send messages to two or more structures at once, so that if one structure gets the message, the other always does, too. Some parts of the body have more sensory neurons than other parts. This is why we say some parts of the body are more *sensitive* than others.

IDENTIFY

In each case, tell whether the impulse for the action or feeling listed would be carried by a sensory neuron or a motor neuron. Put **S** for sensory and **M** for motor.

_S_ pain

_S_ seeing a dog

_M_ petting a dog

_M_ salivating

_S_ cold

_S_ hearing a bell

_M_ writing

_S_ an itch

_M_ scratching

SENSORY NEURONS

1. **Try the following experiment.**
Equipment: two sharpened (but not *too sharp)* pencils

Set-up:
Have your partner close his eyes and turn his back to you, with the skin of his neck exposed.

Procedure:

a. Now take the two pencilss and touch the neck with the points of the pencils, with the pencils about 3 inches apart.
b. Make sure the points touch the skin at the same time.
c. Ask your partner how many points he felt.
d. Now repeat the steps above, but move the points a little closer together.
e. Ask your partner again how many points he felt.
f. Continue the steps until your partner responds that he only felt 1 point.
g. How far apart were the pencils when your partner felt only one point? ____________
h. Now repeat the experiment above, only touch the palm of your partner's hand instead of the neck.
i. How far apart were the pencils when your partner felt only one point?
____

Analysis:
Compare the two results. On which part of the body were the paper clip tips the farthest apart when your partner only felt 1 point? ________
We would say that this part of the body is *less sensitive* than the other part. Sensory neurons are responsible for sending messages about things you feel on your skin. What does this experiment tell you about the sensory neurons in the neck and the palm of the hand? (Hint: Think about the number of neurons.) **ANSWER: The more sensitive areas contain more sensory neurons and the neurons are closer together.**

____

Try to guess other parts of the body that would be less sensitive than the palm of the hand. Make a list of the more sensitive areas of the human body.

THE CENTRAL NERVOUS SYSTEM

The ***central nervous system*** is the control center for the nervous system. All sensory impulses go to the central nervous system. All motor impulses begin in the central nervous system. The central nervous system contains two very important organs: the ***brain*** and the ***spinal cord.***

The brain has several different parts. Each part has a different function. The ***cerebrum*** is the biggest part of the brain. The cerebrum stores information. This is our memory! We use the stored information to think. The cerebrum also controls voluntary actions, like moving your hand. The ***cerebellum*** is the second largest part of the brain. The cerebellum makes muscle actions smooth. It makes coordinates our movements. Without the cerebellum, muscle movements would be very jerky and manual tasks would be difficult. The cerebellum's control of muscles is involuntary. The ***medulla*** is found at the bottom of the brain. It controls involuntary movements, such as breathing. The ***spinal cord*** is a long stem that extends from your brain all the way down your back. The spinal cord conducts messages to and from the brain. Reflex actions are also controlled by the spinal cord.

MATCHING

Draw lines connecting the parts of the central nervous system in the left column with the functions listed in the right column.

cerebellum

cerebrum

spinal cord

medulla

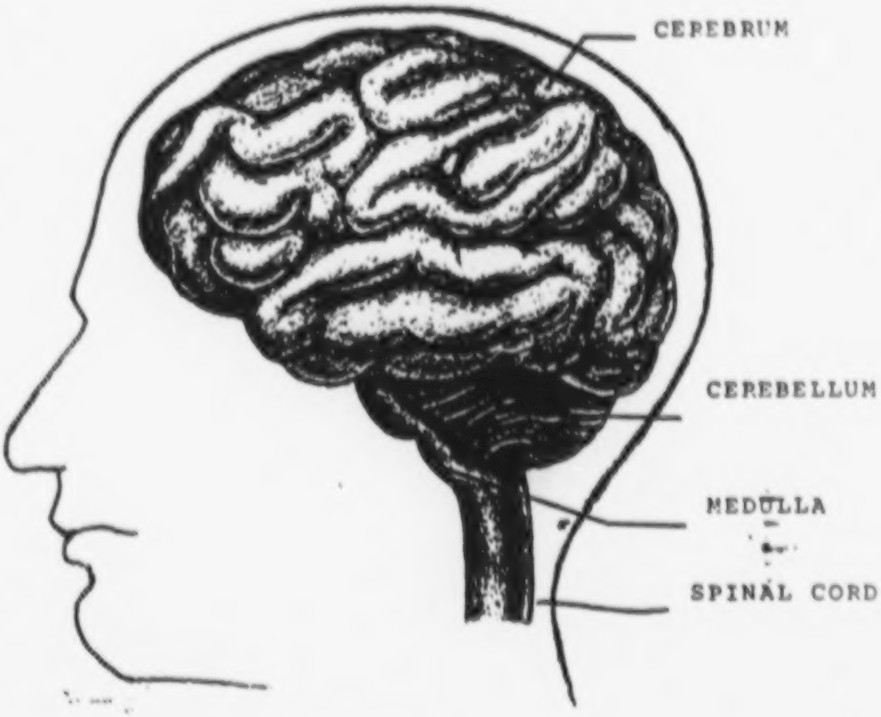
Controls involuntary activities, like breathing, stomach activities, etc.

Controls coordination of voluntary actions; also controls balance and equilibrium.

Controls all voluntary muscle movements; center for memory, thinking, learning, and interpretation of all sensory impulses that enter the brain.

Conducts impulses to and from the brain; controls simple reflexes

Identify the structures in the left column above on the diagram below.



VOLUNTARY VS. INVOLUNTARY ACTIONS

Human beings perform both voluntary actions and involuntary actions. Voluntary actions are actions that you have to want to do, or that you have control over, such as talking, raising your hand, or bending your knee. Nerves that control voluntary actions are called ***somatic*** nerves.

Involuntary actions are actions that your body does automatically, without you thinking about them. Keeping your heart beating and digesting food are two involuntary actions. Nerves that control involuntary actions are called ***autonomic*** nerves.

SYMPATHETIC VS. PARASYMPATHETIC

Autonomic nerves send messages to the organs and glands of the body. These actions cannot usually be controlled by thought. There are two types of autonomic nerves. One type, which is called the ***sympathetic*** division, takes control when you feel excited or when you are in danger. For example, the sympathetic division would tell your heart to beat faster, your respiratory system to breathe faster, and your stomach to stop digesting. The sympathetic division is sometimes called the "flight or fight" response. It stops certain body functions temporarily so that more energy and attention can be devoted to responding to the threat. This is why your heart beats faster when you are scared.

The other type tells the body to carry out body functions when you are not excited or scared. These nerves make up the ***parasympathetic*** division. For example, the parasympathetic division would tell your heart to beat normally, your respiratory system to breathe normally, and your stomach to digest food. The parasympathetic division controls normal functioning of the body. This division takes over when the threat is gone and returns the body to normal.

IDENTIFY

Decide whether each action is controlled by somatic or autonomic nerves. If it is somatic, write an **S** next to the action. If it is autonomic, write **A**. Then decide whether it is controlled by the sympathetic or the parasympathetic division. If it is sympathetic, add **S** to the **A**. If it is parasympathetic, add **P** to the **A**.

_S_ writing

_S_ swallowing

_AP_ pushing food through the esophagus

_S_ smiling

_AP_ regular heartbeat

_AP_ secretion of intestinal juice

_AS_ quickened heartbeat

_AP_ yawning

_S_ closing your eyes

_AP_ salivating

_AS_ crying

_S_ chewing

SEQUENCE

You see a man point a gun at you. You scream. You then realize the gun is a toy. You relax.

Below are the nervous system steps involved in the sequence of events above. The missing steps are listed on the next page. Put the missing steps in the proper places below.

1. Sensory neurons in the eyes detects the gun.
2. Sensory neurons of the peripheral nervous system conduct the impulse.
3. **B)**
4. The brain interprets the impulse.
5. **D)**
6. One set of impulses goes to the somatic nerves that control the muscles that control the vocal cords and you scream.
7. **F)**
8. Sensory neurons detect that the gun is a toy.
9. **A)**
10. The impulse reaches the brain in the central nervous system.
11. **C)**
12. The central nervous system sends 2 sets of impulses to the motor neurons of the peripheral nervous system.
13. **E)**
14. One set of impulses goes to the parasympathetic division of the autonomic nerves and your body functions return to normal.

Missing Steps:

a) Sensory neurons of the peripheral nervous system conduct the impulse.

b) The impulse reaches the brain in the central nervous system.

c) The brain interprets the impulse.

d) The central nervous system sends two sets of impulses to the motor neurons of the peripheral nervous system.

e) One set of impulses goes to the somatic nerves that control the muscles that control the vocal cords and you stop screaming.

f) One set of impulses goes to the sympathetic division of the autonomic nerves and your "fight or flight" response is activated (i.e., heartbeat quickens, etc.)

REFLEXES

Some "voluntary" movements are things you do without thinking about it. These actions are usually in response to something in the environment that surprises your system. The message to respond is sent to the muscles without you thinking about it. Some examples of reflexes are blinking when someone throws something at your face or quickly moving your hand when you touch something hot. Reflexes protect your body by responding quickly to dangerous situations.

A reflex is a very fast action. The sensory impulse is sent to your spinal cord. Instead of going to your brain, the response impulse is sent from the spinal cord to a motor neuron. This impulse tells the muscle to move. This pathway is called a ***reflex arc***.

SEQUENCE

Below are the steps that an impulse travels in a reflex action. Rewrite them in the correct order at the bottom of the page.

spinal cord

long end of a sensory neuron

long end of a motor neuron

long end of an associative neuron

short end of a sensory neuron

short end of a motor neuron

short end of an associative neuron

ANSWER:

1. **Short end of a sensory neuron**
2. **Long end of a sensory neuron**
3. **Spinal Cord**
4. **Short end of an associative neuron**
5. **Long end of an associative neuron**
6. **Short end of a motor neuron**
7. **Long end of a motor neuron**

REFLEX EXPERIMENT

One reflex action is the opening and closing of the pupil of the eye in reaction to light. (The pupil is the black hole in the center of the eye.) When too much light is present, the pupil gets smaller. When too little light is present, the pupil gets larger. This is a way of adjusting the amount of light that reaches the eye.

Try the following experiment. Cover one eye. Have your partner watch what happens to the pupil of the uncovered eye.

1. What happened to the pupil of the uncovered eye?

2. What do you think happened to the pupil of the covered eye?

3. Did you expect the two eyes to react the same way?
ANSWER: You would expect the uncovered eye to stay the same, since the light to the uncovered eye has not changed.

4. Since the amount of light available to the uncovered eye did not change, why did the size of the pupil change?
ANSWER: The pupil of the uncovered eye changed because it is linked to the covered eye.

5. Does this mean that the two eyes are on the same reflex arc or on different reflex arcs? Explain your answer.
ANSWER: The two eyes share a reflex arc. They cannot react independently. If one pupil gets larger, the other must get larger too.

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

Example:

1. **cerebrum** **cerebellum**
[✓ spinal cord] **medulla**

All four of these are parts of the central nervous system. The spinal cord is the "odd word out" because it is not part of the brain while cerebrum, cerebellum, and medulla are.

2. cerebrum [✓ medulla]
somatic nerves motor neuron

Clue: Think about voluntary and involuntary movements.
ANSWER: These are all involved in voluntary movements.

3. [✓ motor neuron] brain
associative neuron spinal cord

Clue: Think about where these things are located in the body. Are they part of the central nervous system or the peripheral nervous system?
ANSWER: These are part of the central nervous system.

4. parasympathetic division sympathetic division
[✓ cerebellum] medulla

Clue: Think about the parts of the body each controls.
ANSWER: These control body organs (involuntary movements).

5. long end of neuron nucleus
[✓ synapse] short end of neuron

Clue: Think about the structure of a neuron. Which are *parts* of a neuron?
ANSWER: These are parts of the neuron. The synapse is a *gap*, not a structure.

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

sensory neuron

central nervous system

nerve impulse

reflex

SENSE ORGANS

The ***senses*** are how you find out what is going on around you. Your sense organs give you information about your environment. Humans have five senses: ***vision, hearing, taste, smell, and touch***. The ***eyes, ears, tongue, nose, and skin*** are sense organs. They each function to provide one of the senses.

ANALYZING THE SENSES

1. Why would it be a disadvantage to have the taste buds for bitter at the back of the tongue? (Hint: What types of foods are bitter?)
   a) Is it easier to avoid swallowing something at the back of the tongue or at the front of the tongue?

ANSWER: Bitter foods are usually foods we do not want to eat. Poisonous foods are often bitter. If you cannot taste bitter until food is at the back of the mouth, it is much harder to avoid eating bitter foods. This is a disadvantage because you are more likely to eat bad or poisonous foods.

2. How does blinking help the eye?

ANSWER: Blinking keeps the eye moist.

3. Sometimes the bones in the ear get stiff and "calcified" — calcium builds up between the bones. How would this affect hearing? Can you think of ways to help the problem?

ANSWER: If the bones are calcified, they are stiff. The sound vibrations cannot move from bone to bone, therefore hearing is stopped. One way to solve the problem is to replace the bones with artificial bones.

4. People who need glasses have a problem with the eye. Their eyes do not focus light on the retina properly. What structure of the eye do eyeglasses imitate or help?

ANSWER: Eyeglasses are like the lens of the eye. They refocus light so it hits the retina properly.

5. People often get ear infections. Bacteria start to grow in the ear canal. The body's defenses fight the bacteria. This creates a thick liquid that blocks off the canal. How would this affect hearing?

ANSWER: This would greatly reduce the amount of sound you could hear. A lot of the sound waves would not make it through the thick liquid. The sound waves that did would be distorted because of going through the liquid before hitting the eardrum.

6. What do you think the wax in the ear does?

ANSWER: Earwax helps keep the ear canal clean. It traps dirt and other particles that enter the ear.

THE ENDOCRINE SYSTEM

ENDOCRINE SYSTEM

Hormones are chemicals manufactured by the body to regulate functions such as metabolism, growth, and reproduction. Hormones are produced by structures called ***glands*** and are carried by the blood to the cells of the body. The system of hormone-producing glands is called the ***endocrine system***.

Endocrine glands are found in many different parts of the body. The thyroid gland, which regulates growth, is located in the neck. The pancreas, which produces insulin so the body can use sugar properly, is found in the abdomen. The ovaries and testes also produce female and male hormones. Glands release hormones directly into the blood stream, so the hormones come in contact with almost all the cells in the body. But most cells ignore the hormones; only the cells that the hormone is designed for can actually use the hormone. For example, only the cells that reflect sex characteristics respond to hormones produced by the ovaries or testes.

CHARACTERISTICS OF THE ENDOCRINE SYSTEM

Put a check mark next to the statements that are true of the endocrine system.

___ Has a specialized network of tubes to carry hormones to body organs

___ Consists of one gland

X___ Secretes hormones into the blood stream

___ Sends hormones only to the target cell

___ Endocrine glands are connected to each other

X___ Endocrine glands are found in many different parts of the body

___ All hormones have the same effect on body organs

X___ Hormones can affect muscles

___ Hormones usually affect all the cells they come in contact with

X___ Hormones can affect cell metabolism

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

growth hormone

secretion

THE EFFECTS OF HORMONES

1. When the *pituitary gland* is removed from an animal, the level of many hormones in the blood falls. However, we know that the pituitary gland ***does not*** produce the hormones that are missing. What is the function of the hormones of the pituitary gland?

ANSWER: The pituitary gland controls the secretions of many other glands. The pituitary gland makes a hormone that tells other glands when to secrete *their* hormones. Without the pituitary gland, many other glands would simply not work.

2. The female body produces testosterone, the hormone that produces male characteristics (like a beard or a low voice). The female body also produces estrogen, a hormone that produces female characteristics (like smooth skin, breast development, no voice change).

a) If the ovaries, which secrete estrogen, are removed, what would happen to the woman?

ANSWER: If the ovaries are removed, the woman no longer has estrogen, so many of the female characteristics begin to disappear. Some male characteristics become more obvious. A woman may grow a small beard, etc.

b) What could be done to stop this from happening?

ANSWER: One way to stop this would be to give the woman estrogen.

3. When the *parathyroid gland* is removed from an animal, the amount of calcium in the blood decreases steadily, no matter how much calcium is in the diet.

a) What cells of the body do you think the hormones of the parathyroid gland affect?

ANSWER: One of the hormones of the parathyroid tells bone cells when to release calcium. Without the parathyroid, the body cannot use the calcium stored in bones.

Hint Questions:

b) What part of the body stores calcium?

c) Does the body use the stored calcium?

AN EXPERIMENT

Examine the experimental results below and answer the questions that follow.

There are two types of pea plants, dwarf and normal. Dwarf pea plants grow only 1/4 as tall as normal pea plants. In this experiment, a set of four types of plants were grown from seeds. One set of dwarf plants was treated with the chemical *giberillin*. One set of normal plants was treated with giberillin. A set of dwarf plants and a set of normal plants were grown without giberillin. The table below lists the average heights of the plants in each category on certain days.

PLANT	DAY 5	DAY 10	DAY 15
Dwarf + Gib.	2.5cm	7.2cm	15.6cm
Dwarf	1.0cm	3.1cm	5.7cm
Normal + Gib	2.3cm	7.4cm	15.8cm
Normal	2.6cm	7.0cm	15.6cm

1. Which plants showed similar growth patterns?

ANSWER: Normal with giberillin, Normal without giberillin, and Dwarf with giberillin

2. Would you say the giberillin caused the normal plant to grow more? Why or why not?

ANSWER: No. Even though the normal plant with giberillin was slightly taller than the normal without giberillin at the end of the experiment, the difference was not enough to matter.

3. What do you think giberillin is?

ANSWER: Giberillin is a plant hormone.

4. What do you think is the difference between dwarf and normal varieties of pea plants?

ANSWER: Dwarf varieties are plants that do not produce the hormone giberillin. Therefore they cannot grow as much as normal plants. Normal plants produce their own giberillin.

5. What plants were the control for the experiment? Could you draw conclusions if you hadn't used controls? Explain your answer. (Refer to the Science Methods unit, p. 5, for information on controls.)

ANSWER: The plants that were not treated with giberillin were the controls. If you didn't have controls, you would have nothing to compare the growth of the experimental plants to. Without controls, the experiment would be meaningless.

6. In what way is giberillin similar to human growth hormone? In what ways is it different?

ANSWER: Giberillin is similar to human growth hormone because they both cause growth. Also, when either is missing from an organism, the organism does not grow as much as it does normally. However, having extra giberillin does not make a plant grow extra tall. Having extra human growth hormone does make you grow extra tall.

INSULIN

Insulin is a hormone that allows your body to take sugar out of the blood and into the cells.

1. What would happen if your body didn't produce enough insulin?
ANSWER: Your cells could not get enough sugar. You would have very high levels of sugar in your blood.

2. What would happen if your body produced too much insulin?
ANSWER: Your cells would take sugar too quickly. The level of sugar in your blood would be very low.

3. How could you help people who don't produce enough insulin?
ANSWER: You could give them injections of insulin to correct the level of insulin in the body.

REPRODUCTION

REPRODUCTIVE SYSTEM

Reproduction means having babies — that is, an adult organism creates a new organism like itself. All living things reproduce, whether they are plants, animals, or bacteria; whether they are made up of one cell or many cells. Reproduction is a way of making sure that a species will continue to exist. If a species stops reproducing, no young animals will replace the older ones when they die, and the species will become extinct.

There are two basic types of reproduction — ***sexual reproduction*** and ***asexual reproduction***. In sexual reproduction a male and a female of the species each contribute 1/2 of the chromosomes needed to create the new organism. In asexual reproduction the young organism receives all its chromosomes from only one adult organism.

FERTILIZATION

Fertilization is the combining of sperm and egg to form an ***embryo***. The embryo will develop into a new organism. Fertilization can occur inside the female's body or outside the female's body. The embryo may develop inside the female's body or outside. Where fertilization occurs and where the embryo develops have a great effect on the number of eggs the female produces.

External fertilization occurs primarily in certain animals that live in or near the water. The female releases eggs into the water. The male releases sperm. But it may be difficult for the sperm to find the eggs and fertilize them. Many of the sperm and eggs die before they ever get together. Also the eggs do not have much protection from the environment. They may be killed by heat or cold, or eaten by other animals. For these reasons, the female must lay hundreds or even thousands of eggs to make sure that a few of them will survive, be fertilized, and mature.

Internal fertilization makes it easier for the sperm to reach the egg, since the sperm is released inside the female's body, near the eggs. For this reason the female does not have to release as many eggs as a female who reproduces by external fertilization would have to release. But when the female lays the fertilized eggs so that they can develop outside her body, the eggs face the same dangers as eggs fertilized externally.

Some animals that reproduce by internal fertilization do not lay eggs. In these animals, the female keeps the fertilized eggs inside her body during their most important period of development. This protects the young animal from dangers that could harm its growth. Because the egg is so well protected, females that reproduce this way provide very few eggs — sometimes only one. The chances are very good that the fertilized egg will survive.

Sexual Reproduction in Most Mammals — Internal Fertilization

1. ***Eggs*** are produced in the ***ovaries*** of the female mammal.

2. ***Sperm*** are produced in the ***testes*** of the male mammal.

3. The eggs move into ***tubes*** attached to the ovaries.

4. The ***penis*** is placed into the ***vagina***.

5. Sperm travel from the testes through the penis. The penis releases sperm into the vagina.

6. Sperm swim from the vagina into the ***uterus*** and then into the tubes.

7. One sperm joins each egg in the tube. This is ***fertilization.***

8. The fertilized eggs move from the tubes into the uterus.

9. The fertilized eggs attach themselves to the wall of the uterus.

10. After the embryos (fertilized eggs in the uterus) have grown into complete animals, they are released from the female's body. This is called ***birth***.

SEQUENCE

Below are the steps for reproduction in mammals. Number the steps in the order they occur.

_2__ Eggs are released from the ovary.

_7__ Sperm swim from the vagina into the uterus and then into the tubes.

_1__ Sperm are produced in the testes of the male and eggs are produced in the ovaries of the female.

_10_ The fertilized eggs attach themselves to the wall of the uterus.

_3__ The eggs move into tubes attached to the ovaries.

_8__ One sperm joins each egg in the tube. This is fertilization.

_9__ The fertilized eggs move from the tubes into the uterus.

_4__ The penis is placed into the vagina.

_11_ The embryos develop inside the uterus.

_5__ Sperm travel from the testes through the penis.

_12_ The developed embryo is released from the female's body.

_6__ The penis releases sperm into the vagina.

WHAT IS MEIOSIS?

Most many-celled plants and animals do not reproduce asexually. They reproduce sexually — that is, sperm cells from a male and egg cells from a female must join before a new organism is produced. Each sex cell — the sperm and the egg — has half of the necessary ***chromosomes*** (genetic information) to form a new organism. When the sperm and egg join each other, the two half sets of chromosomes are combined. So the new organism has a full set of chromosomes with one-half of coming from each parent (each of the original cells).

MEIOSIS

1. The chromosomes inside a cell duplicate and get shorter and thicker. Two complete sets of genetic material are now present in the cell.

2. The original and the copy for each chromosome are joined at the center (as in mitosis).

3. Remember that each chromosome originally had a ***homologous*** "partner" chromosome that contained genes that coded for the same information. The original and copy of each chromosome (still attached at the center) lines up with its homologous partner chromosome (which is also an original and a copy joined together) at the middle of the cell.

4. ***Spindle fibers*** are formed from the ends of the cell to the middle.

5. The homologous partners move to opposite ends of the cell. The original and copy *do not* separate as they did in mitosis, but remain attached and move to the same end.

6. The spindle fibers disappear and a nuclear membrane may form around the chromosome clumps at the poles.

7. The ***cytoplasm*** divides, leaving two cells. Each cell contains an original and a copy of only **1** chromosome from each homologous pair. Therefore, the new cells contain only *half* the number of chromosomes the original cell had, but the new cells have two copies each of these chromosomes.

8. The chromosomes in both of the two new cells again become shorter and thicker.

9. The nuclear membrane disappears.

10. The spindle fibers are formed. The chromosomes line up on the equator.

11. The replicated pairs separate at the center and move to opposite ends of the cell so that the original chromosome and the copy are now at opposite ends.

12. The spindle fibers disappear.

13. A nuclear membrane develops around the clump of chromosomes.

14. The cytoplasm divides and a total of 4 new cells have been produced from the 1 original cell. The resulting cells have *half* the number of chromosomes the original cell had. This is called ***haploid***.

15. The cells formed from meiosis are the gametes which are involved in sexual reproduction. When two haploid cells combine, each having a *half* set of chromosomes, the resulting cell has a *full* set of chromosomes. This is what happens when a sperm and an egg combine to form an ***embryo.***

COMPARING MEIOSIS AND MITOSIS

Complete the chart below. It lists differences and similarities between mitosis and meiosis.

MEIOSIS	MITOSIS
Chromosomes duplicate.	Chromosomes duplicate.
Nuclear membrane disappears	Nuclear membrane disappears.
Homologous pairs of chromosomes line up at the center of the cell.	Homologous pairs of chromosomes *do not* line up at the center.
Replicated pairs do not separate.	Replicated pairs separate and move to opposite ends of the cell.
Homologous pairs separate and move to opposite ends of the cell.	
New nuclear membranes *may* form around chromosome clumps.	New nuclear membranes form around chromosome clumps.
Two new cells result as a *temporary* stage in meiosis.	2 new cells result. This is the final product of mitosis.
The two new cells have half the number of chromosomes as the parent cell.	The two new cells have the same number of chromosomes as the parent cell.
The two new cells repeat the steps of ***mitosis*** except the chromosomes do not duplicate.	
A final total of 4 haploid cells result from meiosis.	A final total of 2 diploid cells results from mitosis.

Sexual Reproduction in Flowering Plants

1. ***Eggs*** are produced in the ***ovary*** of the flower.

2. ***Sperm*** are produced in the ***anther*** of the flower. Sperm are found in ***pollen grains*** (2 sperm in each grain).

3. Wind, insects, or other animals carry a pollen grain from the anther to the ***stigma*** (the sticky surface at the top of the style) of the flower. This movement is called ***pollination***.

4. The pollen grain forms a tube which grows from the top of the style down toward the ovary. There are two sperm in the tube.

5. When the tube reaches the ovary, the two sperm enter the ovary.

6. One sperm joins an egg in the ovary. This is called ***fertilization***.

7. The second sperm joins special cells surrounding the egg to make a food supply for the egg.

8. The ***embryo*** (fertilized egg) and its food cells together are called the ***seed***. The seed goes dormant (it does not develop anymore). The seed will use its food and begin to develop again when it is is under favorable conditions.

POLLINATION

Pollination is the transfer of the pollen from the anthers of one flower to the stigma of another flower. This is a very important step in sexual reproduction in flowering plants. There are two basic methods for pollination. 1) In ***wind pollination*** the wind carries the pollen from the anther of the flower. Some of the pollen may land on the stigma of a compatible flower. 2) In ***animal pollination*** an insect, bat, or bird may land on a flower, usually to get ***nectar*** (a sweet substance produced by flowers). The pollen becomes stuck to the legs or body of the animal. When the animal flies to another flower, the pollen is transferred and may land on the stigma of a compatible flower.

POLLINATION

Below are descriptions of some flowers. For each, decide whether it probably uses wind pollination or animal pollination.

1. A plant has small flowers with very small petals and sepals. The petals are white. The pistils and stamens are very long. They stick out past the petals. The flowers are clustered near the ends of branches.
   a) What method of pollination would you guess this plant uses?

ANSWER: The flower is probably wind pollinated.

   b) Why?
   c) How does the structure of the flower help in this method of pollination?

ANSWER: The petals are small so they do not block the wind from the stamens. Since the pistils and stamens are long, it would be easier for pollen to be caught in the wind and for pollen to land on a stigma.

2. A plant has very colorful flowers. The petals are brightly colored and rather large. The bottom petals are flattened into a broad, flat surface. The flower has a pleasant odor. The stamens are in a circle around the pistil. The stamens are fairly short and do not stick out past the petals. The anthers hang near the nectar producing structures of the flower.
   a) What method of pollination would you guess this plant used?

ANSWER: The flower is probably insect pollinated.

   b) Why?
   c) How does the structure of the flower help in this type of pollination?

ANSWER: The broad petals create a "landing strip" for the insect. The anthers are located near the nectar so that insects gathering nectar will brush against the anthers and pick up pollen.

   d) How does the odor and color of the flower affect pollination?

ANSWER: The color and odor would help to attract insects to the flower.

ASEXUAL REPRODUCTION

In ***asexual reproduction***, one organism produces another organism just like itself. Sex cells are not involved. Cells do not have to go through meiosis. This makes reproduction easier. However, since the new organism is just like the parent, there is no genetic variation. Asexual reproduction usually occurs in small organisms that are not very complex. Some organisms reproduce asexually and sexually.

There are several types of asexual reproduction. ***Binary fission*** is a type of asexual reproduction used by some one-celled organisms. Binary fission is like mitosis. The cell duplicates its chromosomes and then divides into two new cells. ***Budding*** is a type of asexual reproduction found in both one-celled organisms and many-celled organisms. The organism begins to grow a small "bump" on the outside. The bump looks like the adult. After the bump reaches a certain size, it falls off and becomes a new organism. ***Regeneration***, also called ***vegetative reproduction***, is a type of asexual reproduction found in many-celled organisms. The organism simply breaks off part of its body. This broken part grows into a new organism. The missing part is regrown on the parent organism. Some organisms split in half and each grows into a whole organism. Finally, ***sporulation*** is another type of asexual reproduction. It can occur in one-celled or many-celled organisms. The organism, usually fungi and some plants, produce ***spores***. Spores are small, hard grains similar to seeds. The spores are released from the parent. Each spore can become a new organism. Spores sound very similar to seeds. But remember that seeds are produced from sexual reproduction.

MATCHING

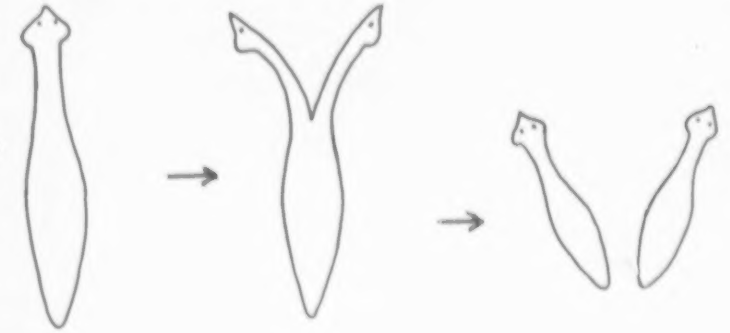
Match the types of asexual reproduction listed in the left column with the pictures in the right column.

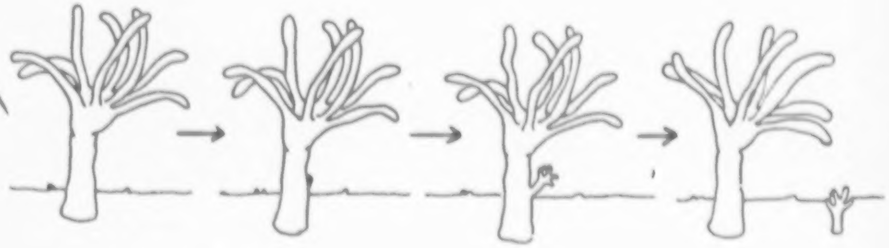
Budding

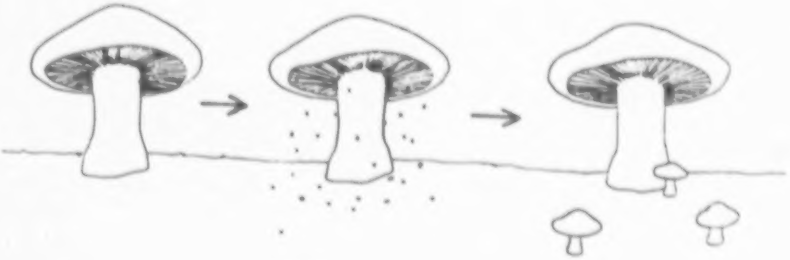
Binary Fission

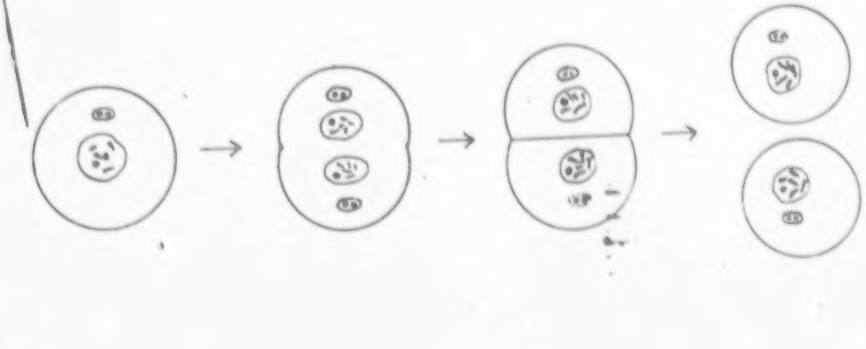
Regeneration

Sporulation









IDENTIFYING TYPES OF ASEXUAL REPRODUCTION

Read the paragraphs below. Each describes an organism and its type of asexual reproduction. Write the name of the type of asexual reproduction in the space provided.

1. The hydra is an animal that can reproduce asexually. The parent hydra produces tiny organisms just like itself that grow out of its side. After the tiny organism has reached a certain size, it falls off and becomes an independent animal. **Budding**

2. Bread molds usually reproduce asexually. A special structure at the tip of the mold stores spores, one-celled structures that are capable of surviving independently for a long time without any food. These spores are released from the mold. When they land in a good place (one with food and water), the spores begin to grow into another mold. **Sporulation**

3. *Escheria coli* is a bacteria that lives in the intestines. To reproduce, it makes a copy of its chromosome. It then divides itself into two equal parts, each with a copy of the chromosome. This leaves two new, complete *Escheria coli* bacteria. **Binary fission**

4. A planaria is an animal that may sometimes reproduce asexually by spontaneously splitting down the middle. Each half then grows into a complete planaria. **Regeneration**

5. Many fungi reproduce asexually. Part of the "branch" of the fungus breaks off. The piece grows into a new fungus. **Vegetative**

COMPARING SEXUAL AND ASEXUAL REPRODUCTION

Read the statements below. Decide whether each statement applies to sexual reproduction, asexual reproduction, both, or neither. Put an S (for sexual), A (for asexual), N (for neither), or B (for both) in the space provided.

S Gametes are produced.

A Offspring have a genetic code identical to the parent.

B An offspring of the same species as the parent is produced.

N The offspring are genetically different from the parents.

S Two organisms are usually involved.

A The parent may be reduced in size after producing offspring.

B The offspring must go through development stages before becoming an adult.

A Only one organism is ever involved.

S Meiosis occurs.

N Genetic variation always occurs.

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

1.	meiosis [✓ two cells]	four cells haploid	**Meiosis produces four haploid cells**
2.	[✓ embryo] sperm	egg pollen	**These are all haploid sex cells**
3.	budding binary fission	[✓ fertilization] regeneration	**These are types of asexual reproduction**
4.	insects birds	bats [✓ wind]	**These are animal pollinators**

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

embryo

pollination

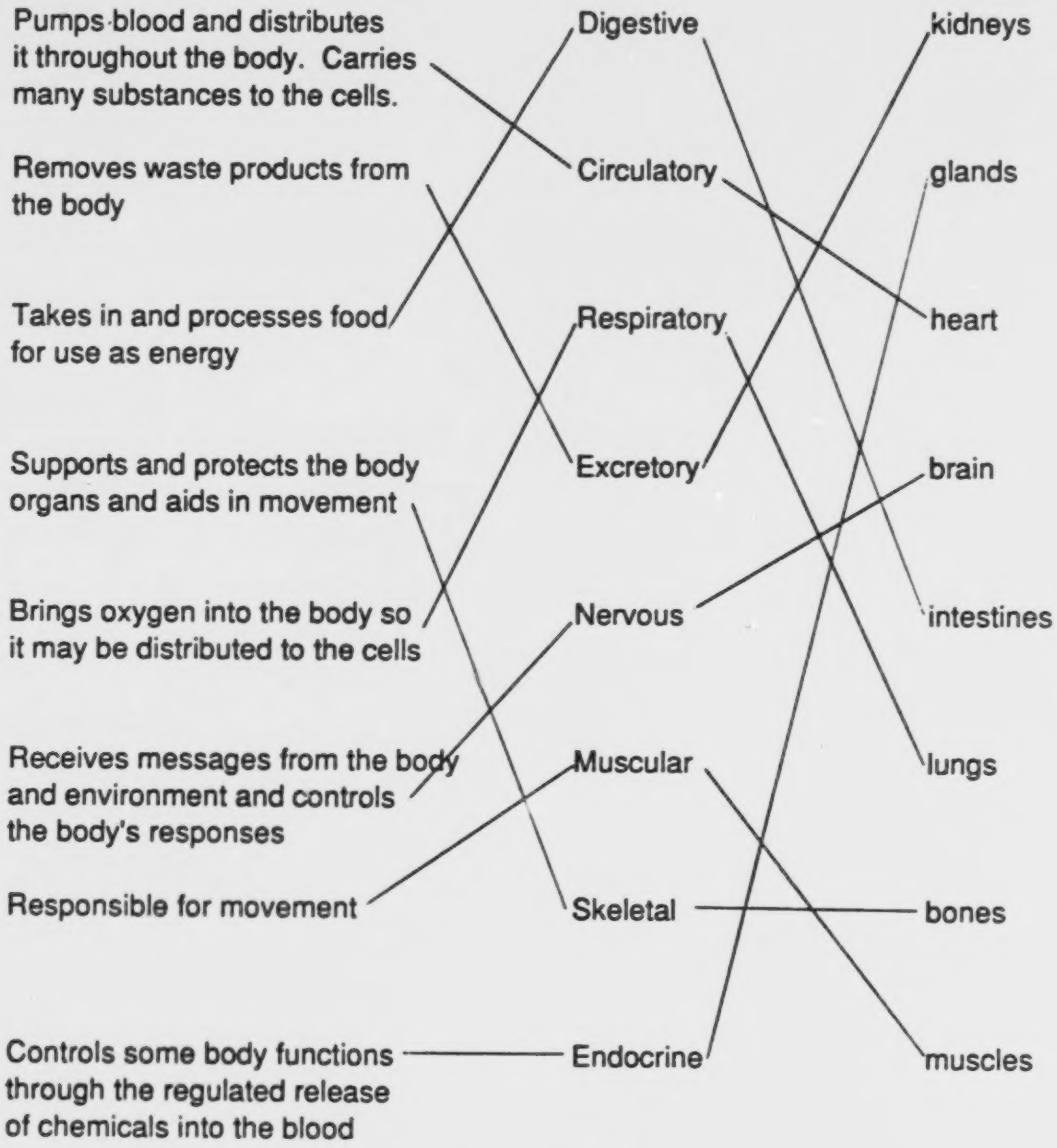
INTEGRATED SYSTEMS

INTEGRATED SYSTEMS

By now, you have studied the 9 organ systems of the human body. You should know how each system works. However, it is important to realize that no system works completely independently. Every system depends on the proper functioning of the other systems. To understand completely how the body functions, you must think about how the systems work together as a team. The following questions concern all the organ systems and how they interrelate.

MATCHING

Match the systems listed in the left column with their primary function in the middle column, and with the primary organ involved, listed in the right column.



Pumps blood and distributes it throughout the body. Carries many substances to the cells.

Removes waste products from the body

Takes in and processes food for use as energy

Supports and protects the body organs and aids in movement

Brings oxygen into the body so it may be distributed to the cells

Receives messages from the body and environment and controls the body's responses

Responsible for movement

Controls some body functions through the regulated release of chemicals into the blood

Digestive

Circulatory

Respiratory

Excretory

Nervous

Muscular

Skeletal

Endocrine

kidneys

glands

heart

brain

intestines

lungs

bones

muscles

For each system listed, check the systems underneath that are directly involved in the functioning of the first system. (Note that all systems are vital for life. Check only the systems that are involved in normal functioning. That is, don't check respiration for all the systems just because oxygen is necessary for anything in the body to work.)

Example:

1. DIGESTIVE SYSTEM

X circulatory
__ endocrine
__ respiratory
X muscular
__ skeletal
__ excretory

The circulatory system is necessary to transport the nutrients from the intestines. Muscles are responsible for moving food through the digestive system.

2. CIRCULATORY SYSTEM

__ digestive
X muscular
__ skeletal
__ respiratory
X nervous

Muscles make the heart beat, to push blood through the circulatory system. The nervous system tells the heart when to beat.

3. NERVOUS SYSTEM

__ circulatory
__ digestive
__ respiratory
__ skeletal

None of these are necessary for the nervous system to work properly.

4. RESPIRATORY SYSTEM

__ digestive
X circulatory
X muscular
X nervous

The circulatory system carries the oxygen to the cells. The muscles of the rib cage and the diaphragm make breathing possible. The nervous system tells the muscles when to move.

5. ENDOCRINE SYSTEM

X circulatory
__ digestive
X nervous
__ reproductive

The circulatory system carries hormones to the cells. The nervous system can tell glands when to secrete hormones.

6. MUSCULAR SYSTEM

X skeletal
__ excretory
X nervous
__ reproductive

Many muscles attach to bones of the skeletal system. The nervous system tells muscles when to contract.

GUESS THE CATEGORY

Some categories are listed below. Your job is to list things that fit into that category for your partner. Some examples of things you could list are given after each category. Your partner will try to guess the category. See how many categories your partner can guess in 1 minute. (Your partner also has a list of categories. Take turns giving clues and guessing.)

1. Things in the blood
   Examples: nutrients
   platelets
   hemoglobin

2. Things that are excreted
   salt
   water
   ammonia

3. Parts of the digestive system
   stomach
   esophagus

4. Reactions to the sympathetic nervous system
   increased heart rate
   dilated pupils
   decreased appetite

Below are ten words. They are in alphabetical order. Give your partner short clues for each word to help him/her guess them. If your partner is having trouble, you may skip a word and come back to it. Try to get all the words in less than 1 minute. Your partner knows the first letter of each word. Tell him when he guesses the correct word. (Your partner also has a list of words. Take turns giving clues and guessing.)

EXAMPLE: A - Artery Clue: Blood vessels that carry blood to the heart.

B	**C**	**D**	**E**	**F**	**G**
blood	carbohydrates	digestion	exoskeleton	food	growth

H	**I**	**J**	**K**
hormones	involuntary	joints	kidney

The words in your partner's book start with the following letters, in this order:

L M N O P Q R S T U

SYSTEMS INVOLVED

After each description, list the systems that are involved in the situation described. Briefly tell how each system is involved.

1. Juan eats a candy bar and his body uses it for energy.
ANSWER: The *muscular system* allows food to be chewed. The muscles are attached to the bones of the *skeletal system.* The *nervous system* tells the muscles to move. The *digestive system* breaks the food down so the body can use it. The *circulatory system* takes the nutrients to body cells. The *endocrine system* produces hormones that allow the cells to use the nutrients.

2. Carol throws a baseball toward home plate.
ANSWER: The *sensory organs* locate home plate. The *nervous system* tells the *muscular system* to move. The muscles are attached to the *skeletal system.*

3. Marie's body is able to fight off a bacterial infection.
ANSWER: The *circulatory system* produces antibodies that kill the invading bacteria.

4. Jane's ovaries release a mature egg cell.
ANSWER: The *reproductive system* produces the egg. The *endocrine system* produces hormones that stimulate the egg to mature and to be released.

5. Jim deeply breathes in the clean, mountain air.
ANSWER: The *respiratory system* brings air into the lungs. The *muscular system* helps in inhalation. The *skeletal system* provides a place for the muscles to attach. The *circulatory system* takes the oxygen to the cells.

SYSTEM SIMILARITIES

1. List all the systems that use diffusion in performing their functions.

ANSWER:

Circulatory System
Digestive System
Endocrine System
Respiratory System
Excretory System

2. List all the systems that use the circulatory system to perform their function.

ANSWER:

Digestive System
Endocrine System
Respiratory System
Excretory System

3. List all the systems that include some type of tube structure. Is there a similarity in the functions of these systems?

ANSWER: All these systems transport substances through the body.

Digestive System
Circulatory System
Respiratory System
Excretory System
Reproductive System

4. List all the systems that take some product from outside the body and bring it into the body.

ANSWER:

Respiratory System
Digestive System

5. List all the systems that expel something from the body.

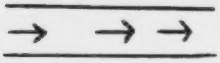
ANSWER:

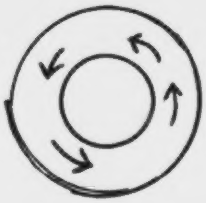
Respiratory System
Digestive System
Excretory System
Reproductive System

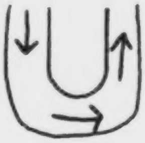
ONE WAY STREET OR A DEAD END?

Many systems transport substances and messages throughout the body. There are two major types of transportation pathways.

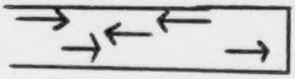
1) **One-Way Transport** — Substances may move in only one direction along the pathway. This is much like a one-way street. The shape of the street is not what matters. What is important is that traffic goes only one way.

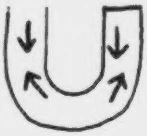






2) **Dead End Transport** — Substances can move in either direction along a pathway (in or out). This is like a dead end street, where cars can go either direction, driving anywhere on the road, but they must exit the way they entered.





Classify the following systems of human beings into one of the two categories above. Explain your answers.

Digestive — **One-Way**
Circulatory — **One-Way**
Respiratory — **Dead-End**
Excretory — **One-Way**
Nervous — **One-Way**

Which seems most efficient, one-way or dead end? Why?
ANSWER: One-way is more efficient. Reactants and products cannot mix in a one-way system. This means that the things you want to stay in the system stay. The things you want to leave the system can leave. Think what would happen if undigested food left the body the same way new food entered the body. Think about the air that leaves the respiratory system. Has all the oxygen been removed? The carbon dioxide and the oxygen mix in the lungs, making respiration less efficient than if it were a one-way system.

ANIMAL VARIATIONS

1. In most animals, the respiratory system and the digestive system share some structures, like the mouth and the pharynx. The *lamprey* is a fish that is a parasite. The lamprey attaches its whole mouth to the side of a big fish and sucks the fish's blood to get nutrients.

   a) Do you think the lamprey's respiratory system and digestive system share any common structures?

ANSWER: The lamprey's digestive and respiratory systems do not share any structures.

b) Why or why not?

ANSWER: When the lamprey is eating, the whole mouth is stuck to the side of the fish. The lamprey cannot bring water in through the mouth while it is eating. The respiratory system brings water in through nostrils located over the mouth. This way the lamprey can breath while it is eating.

2. Clams often live buried many centimeters under the ocean floor. They filter food and oxygen from the ocean water. Long tubes go from the clam's body to the water. The tubes bring in water and then expel it. Do you think the respiratory and digestive systems share the water from the same tubes? Why or why not?

ANSWER: The clam's digestive and respiratory systems *do* share the same tubes. Since the water contains both oxygen and food, the same water can be brought to the clam, where oxygen and food are removed, and then moved to the correct system. There is no reason for the clam to bother with separate tubes for the respiratory and digestive systems.

3. Skin may serve several different purposes in different animals. What are they? What different organ systems could skin belong to?

ANSWER: The skin can be a sense organ, providing information about the environment. The skin can also be used for respiration and excretion. The skin can also absorb nutrients from the environment.

YOU'RE THE DOCTOR

Below are descriptions of patients that have come to see you. Use your knowledge of the body systems to diagnose the problem. In some cases, it may be necessary to have medical tests performed to diagnose the problem. ***Tutor: If your partner asks for test results, read the results given. If there are no results given, that test is not important.***

The possible tests are

a) blood analysis
b) urine analysis
c) listen to heartbeat
d) check for clogged arteries and veins

1. The patient has difficulty performing manual tasks, such as walking or talking, smoothly. Movements are jerky and uncoordinated. What body system do you think is causing the problem? What specific structure is probably injured?

ANSWER: The nervous system is probably not working properly. A good guess is that the cerebellum of the brain is injured.

2. The patient is generally weak. Breathing is not difficult, but the number of breaths per minute is higher than normal. There is pain in the left side of the chest. Some fluid is found in the alveoli of the lungs. What system is causing the problem? What things would you check? What structure is not performing correctly? (Be specific).

TUTOR: There are no clogs in any arteries or veins. However, there is a low blood flow in the aorta. The second beat of the heartbeat is weak and sometimes missing.

Answer: The circulatory system is not working properly. The left atrium is probably not pumping blood right. Since blood is not being pumped to the body well, the body is not getting enough oxygen. That is why the breathing rate is increased. Since blood is not being moved through the heart correctly, blood is backing up into the lungs.

3. The patient has a high breathing rate and general weakness and dizziness. Rate of heart beat is also increased. What else would you check?

TUTOR: Blood vessels are not clogged. Heart action appears normal. Blood analysis reveals a low red blood cell count. What structure is probably malfunctioning?

ANSWER: Since the red blood cell count is low, there is not enough hemoglobin to carry oxygen. The bone marrow is probably not producing enough red blood cells.

4. The patient is very thin, even though he is eating normally. The patient is also very tired. What tests would you perform?
   Based on these results, what do you think is the problem?

TUTOR: Blood analysis reveals a high sugar level. Urinalysis reveals a high sugar level.

ANSWER: Since the patient is eating normally, sugar should not be found in the urine. The high sugar level in the blood indicates that sugar is not being taken into the cells properly. The pancreas may not be producing enough insulin.

5. The patient has severe pain in the lower back, near the left side. Urine production is low. What test would you perform?
   What might be causing the low urine output, the pain, and the results of the test?

TUTOR: Urinalysis shows some blood in the urine, but otherwise it is normal.

ANSWER: The cause might be something stuck in the urinary tract. Since the pain is in the lower back, it indicates that the ureters or the kidney may be affected. The blocked tubes would keep some urine from going through the excretory system. The blood in the urine may indicate some cuts in the tubes of the excretory system.

6. The patient has several broken bones. The bones broke very easily. What might be causing the "brittle bones"? What test could you run?

TUTOR: Blood analysis reveals a very low calcium level.

ANSWER: The bones are very weak. Calcium is what makes bones strong. The bones may not be storing calcium properly. However, since the blood calcium level is also low, it may be that the person is simply not eating enough calcium. Since there is not enough calcium in the diet, the body is taking too much calcium from the bones. This would cause the bones to be weak and to break easily.

OCCUPATIONAL HAZARDS

Many jobs can be harmful to your health. Different jobs have different risks. These risks are called ***occupational hazards***. Read the job descriptions below and tell which systems you think would be most affected by each job.

1. Football Player — A football player goes through intensive physical training through most of the year to build muscles and strengthen bones. During football season, the football player performs strenuous physical activity every week. The player is often hit and bruised by other players.
ANSWER: The football player's muscular and skeletal systems would probably be hurt the most. Specifically, the joints are most likely to be injured. The frequent hits from other players can twist bones and injure muscles.

2. Coal Miner — A coal miner works deep underground digging coal. The air underground is very thick with small particles of dust and coal. Also, some poisonous gases may be present in the mine.
ANSWER: A coal miner must be careful not to breathe dangerous gases. Also, the small dust particles can destroy the lungs slowly. Coal miners frequently get diseases of the respiratory system, including lung cancer and emphysema.

3. Boxer — Boxers go through intensive physical training throughout the year to keep their bodies in good shape. During a boxing match, a boxer is usually hit many times, often in the head. The object of a boxing match is to knock your opponent unconscious.
ANSWER: Boxers frequently have injuries to the muscular and skeletal systems. But most often, the boxer's nervous system is hurt. The frequent blows to the head and being knocked unconscious damage the brain.

4. Pianist — A pianist must practice playing the piano for many hours each day. The pianist moves her fingers over and over in the same way.
ANSWER: Pianists frequently get *arthritis*. Arthritis is a disease where joints get swollen and don't move properly. Moving a joint over and over the same way for a long time can cause arthritis.

FUNNY PHRASES

Below are some sentences. These sentences contain phrases that use terms related to body systems. These are phrases used in everyday conversation. They often don't mean what they seem to mean or don't seem to make any sense at all. See if you can guess what each one means. How is the meaning of the phrase related to the function of the body part or system mentioned?

1. The violence in the movie *turned my stomach.*
ANSWER: The movie made me feel sick. I didn't like the violence.
2. Before I gave the speech, I had *butterflies in my stomach.*
ANSWER: I felt nervous before I gave the speech.
3. I found John's explanation *hard to swallow.*
ANSWER: I didn't believe John's explanation.
4. *Don't bite off more than you can chew.*
ANSWER: Don't try to do more work than you are capable of.
5. When the movie ended, my *heart was in my mouth.*
ANSWER: I was very scared after the movie.
6. Tarey's *heart stood still* while they announced the winner.
ANSWER: Tarey waited anxiously while they announced the winner.
7. The nominee's speech *made my blood boil.*
ANSWER: The speech made me very angry.
8. I can't *catch my breath.*
ANSWER: I am breathing very fast and I can't breathe normally.
9. Jeff gave the answer *at the top of his lungs.*
ANSWER: Jeff yelled the answer very loud.
10. Don't *rack your brains* for the answer.
ANSWER: Don't try so hard to come up with the answer.
11. The movie was *spine-tingling.*
ANSWER: The movie was very scary.
12. Have you *moved a muscle* since I left?
ANSWER: Have you been sitting in the same place ever since I left?
13. Maria is just *skin and bones.*
ANSWER: Maria is very skinny.
14. Don't get your *nose out of joint* over Jane's comments.
ANSWER: Don't let Jane's comments upset you so much.
15. I may not know everything, but *I wasn't born yesterday.*
ANSWER: I know more than you think I do.

GENETICS

GENETICS

A ***trait*** is a characteristic of a living thing. Your height, your blood type, and the shape of your ears are all examples of traits. Traits are ***inherited,*** that is they are passed from parents to their offspring. The study of how traits are inherited is called ***genetics.***

Every species of living thing has a specific number of chromosomes. Human beings have 23 chromosome pairs, for a total of 46 chromosomes. Every cell in the body has these 46 chromosomes, because these chromosomes carry the information that the cells need to function and reproduce. The only exceptions are the sex cells (egg and sperm) which have only 1 member of each chromosome pair, for a total of 23 chromosomes each. (Of course, when a sperm fertilizes an egg, this brings the chromosome count up to 46 again.)

The ***chromosomes*** in the nucleus of the cell contain the genetic information which determines traits. Chromosomes are made up of a substance called ***DNA*** (deoxyribonucleic acid). DNA is made up of several different chemicals and has an extremely complicated structure. The chemicals along the chromosome are arranged in special sequences called ***genes***, much like the letters in a sentence are arranged in special sequences called words.

Each gene determines a specific trait, and genes found on the same chromosome are normally inherited together. For example, in the fruit fly, the gene for eye color and the gene for wing shape are found on the same chromosome, so if a fly has eyes the same color as its mother, it will probably have wings the same shape as the mother.

Some traits are more likely to appear than other traits. For example, every child receives one gene for eye color from his mother and one gene for eye color from his father. If the mother's gene is for "blue" and the father's gene is for "brown", the child's eyes will be brown. We say that "brown eyes" is ***dominant*** (determined by a ***dominant gene***) and "blue eyes" is ***recessive*** (determined by a ***recessive gene)***. A child can have blue eyes only if the mother's eye-color gene and the father's eye-color gene are both coded for "blue."

Sometimes neither gene is dominant. This is called ***codominance***. The two traits may combine. For example, a red flower mated with a white flower could produce pink flowers. Sometimes *both* traits show. For example, a person with type A blood who marries a person with type B blood could produce children with type AB blood.

DESCRIBING TRAITS AND GENES

When we are describing someone, we can either talk about their physical characteristics or their genetic makeup. The physical traits of a person are called the person's ***phenotype***. For example, blue eyes is a phenotype. The genes that code for the traits are called the ***genotype***. For example, the genes **bb** code for blue eyes. It is important to talk about this difference because people with the same phenotype (physical traits) do not always have the same genotype (genes).

There are two possible genotypes for a trait. Remember that we get one set of genes from each parent. So we have two genes for every trait. If your mother has blue eyes, she gives you the gene **b** for blue eyes. If your father also has blue eyes, he gives you the gene **b** for blue eyes. You then have the genes **bb** for blue eyes. This is called ***homozygous***. Homozygous means when both your genes for a trait are the same. But suppose your father had brown eyes. He could give you the gene **B** for brown eyes. In this case, you would have the genes **Bb**. This is called ***heterozygous***. Heterozygous means the two genes for a trait are *not* the same.

SIZE

Rank the following particles in order of decreasing size.

_1_ chromosome

_4_ nucleotide

_3_ gene

_2_ DNA

CHROMOSOME NUMBER

Answer the following questions about chromosome number.

1. Which would have more chromosomes?
   a) a sperm cell
   [✓ b) a blood cell]
   c) an egg cell

2. Which would have more chromosomes?
   [✓ a) a fertilized egg cell]
   b) a sperm cell
   c) an egg cell

3. Human body cells have 23 ***pairs*** of chromosomes.
   a) How many total chromosomes is this? 46
   b) How many chromosomes would a sperm cell have? 23
   c) How many chromosomes would an egg cell have? 23
   d) How many chromosomes would a fertilized egg cell have? 46

PHENOTYPE VS. GENOTYPE

Place a P next to the descriptions of phenotype and a G next to the descriptions of genotype.

P A man has 6 fingers.

G A man has the gene for 6 fingers

P The flower is purple

G The flower is heterozygous for purple

G The mutant gene for short wings is present

P The bacteria produces lactic acid

P The boy looks like his father

True or False

F 1. Two organisms with different genotypes always have different phenotypes.

T 2. Two organisms with the same genotype usually have the same phenotype.

F 3. Two organisms with the same phenotype usually have the same genotype.

GAMETES AND GENOTYPE

In each case, give the possible genotypes of the gamete.

Example:

1. Parent: Dd
Gametes: D or d

2. Parent: DD
Gametes: **D**

3. Parent: DD Tt
Gametes: **DT or Dt**

4. Parent: Dd Tt
Gametes: **Dt or DT or dT or dt**

5. Parent: dd Tt Rr Yy
Gametes: **dTRY, dtRY, dTrY, dTRy, dtrY, dTry, dtRy, dtry**

Fill in the missing genotypes.

Father: Dd Mother: dd
Sperm: d Egg: d
D

Fertilized egg:
dd Dd

Father: DdTt Mother: ddTT
Sperm: DT Egg: dT
Dt
dT
dt

Fertilized egg:
DdTt DdTt ddTT ddTt

GAMETES

Which of the following genotypes would produce the greatest number of *different* gametes?

1. AAWWZz
2. aawwZz
3. Aawwzz
4. AaWwzz
5. AAWWZZ

RECESSIVE VS. DOMINANT

Put an R next to statements about recessive genes. Put a D next to statements about dominant genes.

R Two of the gene are necessary for the phenotype to be present.

D One of the gene is necessary for the phenotype to be present.

R The gene may be present without the physical characteristic showing.

D If the gene is present, the physical characteristic will show.

D A capital letter is usually used to represent the gene.

R A lower case letter is usually used to represent the gene.

MATING RABBITS

The gene **D** codes for dark hair and the gene **d** codes for light hair in rabbits. The gene **T** codes for tough hair and the gene **t** codes for soft hair in rabbits.

Fill in the missing genotypes below.

Father: **DDTt**
Sperm: DT or Dt

Mother: **ddTt**
Egg: dT or dt

Complete this Punnett Square for the mating above.

	dT	dt
DT	DdTT	DdTt
Dt	DdTt	Ddtt

Rewrite the possible genotypes of the offspring in the blanks below.

DdTt **DdTT** **Ddtt**

For each genotype, tell what the phenotype would be.

ANSWERS:
DdTt — Dark, tough hair
DdTT — Dark, tough hair
Ddtt — Dark, soft hair

PUNNETT SQUARE

In dogs, dark hair (D) is dominant over light hair (d). Short hair (S) is dominant over long hair (s). A female dog with white, long hair mates with a male dog with dark, short hair (DdSs). Draw a Punnett Square to find out what genotypes their puppies could have.

	DS	Ds	dS	ds
ds	DdSs	Ddss	ddSs	ddss

Write the phenotypes for each of the genotypes above.

ANSWERS:

DdSs — dark, short hair
Ddss — dark, long hair
ddSs — light, short hair
ddss — light, long hair

PARENTS AND OFFSPRING

The gene **S** codes for straight wings and the gene **s** codes for crooked wings. The gene **R** codes for rough eyes and the gene **r** codes for smooth eyes.

Below are the genotypes of the mother and father fly. Fill in the genotypes of the sperm, egg and fertilized egg.

First Generation

Father: SSRR　　Mother: ssrr
Sperm: **SR**　　Egg: **sr**

Fertilized egg: **SsRr**

A) What is the phenotype of the father? **Straight wings and rough eyes**
B) What is the phenotype of the mother? **Crooked wings and smooth eyes**
C) What is the phenotype of the baby fly? **Straight wings and rough eyes**

Second Generation

Two of the baby flies mate with each other. Write their genotypes. Also fill in the possible genotypes of the sperm and egg.

Father: **SsRr**　　Mother: **SsRr**
Sperm: **SR, Sr, sR, sr**　　Egg: **SR, Sr, sR, sr**

Third Generation

Use a Punnett Square to find all the possible combinations of their offspring then answer the questions on the next page.

	SR	Sr	sR	sr
SR	SSRR	SSRr	SsRR	SsRr
Sr	SSRr	SSrr	SsRr	Ssrr
sR	SsRR	SsRr	ssRR	ssRr
sr	SsRr	Ssrr	ssRr	ssrr

A) What proportion of these offspring (third generation) will *look* like their parents (second generation)?
Answer: 9 out of 16

B) What proportion of these offspring (3rd generation) will *look* like their **grandmother** (1st generation)?
Answer: 1 out of 16

C) How many have straight wings and smooth eyes?
Answer: 3 out of 16

D) How many have crooked wings and rough eyes?
Answer: 3 out of 16

E) How many different genotypes produce straight wings and rough eyes?
Answer: 4
They are: SSRR, SSRr, SsRR, and SsRr

RECESSIVE & DOMINANT

1. An albino is a person without any coloring. The hair is white and the eyes are pink. Albinism is carried by a recessive gene. A man and a woman are both heterozygous (Aa) for albinism.
   a) What are the chances that some of their children will be albino?
   Answer: 1 in 4 (1/4)

   b) Will any of their children be normal?
   Answer: You would expect 3/4 to be normal

   c) Are the parents albino?
   Answer: No. They are heterozygous, so they do not show the recessive trait.

2. Can it be proven (without looking at gene sequences directly) that an animal is *not* heterozygous for a recessive gene? Explain your answer.
   Answer: You could not *prove* that it was not heterozygous. Even if the organism never produced any offspring with the recessive trait, you could not be sure that the organism was homozygous. If the organism produced some offspring with the recessive trait, you would know that it *was* heterozygous.

3. A man and a woman both have blue eyes, a recessive trait.

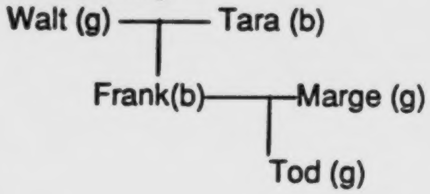
   a) Will any of their children have blue eyes? Explain
   Answer: All their children should have blue eyes. Since blue is recessive and the parents show the trait, they must be homozygous. Thus their children will be homozygous recessive also.

   b) Will any of their children have brown eyes? Explain
   Answer: None of the children should have brown eyes. (See the explanation for question a)

4. Some people have a gene that codes for very short fingers. Celeste is a woman who has short fingers. She marries John, a man who has normal fingers. They have six children. All of the children have short fingers.
   a) Do you think the gene for short fingers is dominant or recessive?
   b) Is the gene for normal fingers dominant or recessive?
   c) Explain your reasoning for both answers.

Answer: Short fingers is probably dominant, since all the children had short fingers. Normal fingers is probably recessive. If normal fingers were dominant you would expect some children to have normal fingers. However, you cannot be sure since six children is not enough information.

5. Walt has green eyes. He marries Tara, who has brown eyes. They have 8 children. All of the children have brown eyes. One of the sons, Frank, marries Marge, who has green eyes. Their son, Tod, also has green eyes. Answer the following questions. Explain your reasoning.
   a) Do you think green eyes is dominant or recessive?
   Answer: Recessive



   b) What do you think Tara's genotype is?
   Answer: You can't tell
   c) What do you think Frank's genotype is?
   Answer: heterozygous (Bb)
   d) What do you think Tod's genotype is?
   Answer: homozygous recessive (bb)

Since green eyes does not appear in Frank, but reappears in his child, Tod, green eyes is probably recessive. Walt passed the gene to Frank, who did not show the trait. Frank then passed the gene to Tod. Since Marge also had the gene for green eyes, Tod showed the phenotype.

6. John goes on a hike through the woods. He comes across a violet with red flowers. Violets usually have purple flowers.
   a) How could John test to find out if the gene for red flowers is dominant or recessive? **Answers will vary.**

   John takes the plant home and grows it. He self-pollinates the plant (both gametes come from the same plant). All of the flowers grown from the seeds are red.
   a) Does this tell you whether the red gene is dominant or recessive?
   Answer: No. The plant could be homozygous recessive.
   b) Can you tell if the plant is homozygous or heterozygous?
   Answer: You cannot be sure, but it is probably homozygous.

HOMOZYGOUS & HETEROZYGOUS

1. Genetics is used in animal breeding. Animal breeders want their animals to be "pure" stock.

   a) What do you think they mean by pure?
   Answer: Pure stock refers to an animal that always produces offspring with the same phenotype as itself.

   b) What genotype do they mean?
   Answer: This is a homozygous genotype.

   c) Why wouldn't they want "unpure" stock?
   Answer: Heterozygous (unpure) stock is bad because you cannot be sure what the offspring will look like.

2. People who *do not* have a genetic disease, but who's offspring can have the disease, are known as carriers.
   a) Why do you think we call them carriers?
   Answer: We call them carriers because they get the gene for the disease from their parents, but they do not have the disease. However, they can pass the gene for the disease on to their offspring. They "carry" the disease without having the disease.

   b) Is their genotype homozygous or heterozygous for the disease-causing gene?
   Answer: They are heterozygous, since they carry the gene for the trait but don't show the trait.

   c) Do you think the disease-causing gene is dominant or recessive?
   Answer: If the gene is present, but the trait does not show, the gene must be recessive.

THE GENE POOL

1. These two traits are dominant traits.
   Six-fingers Short fingers

   If these traits are dominant, why don't most people have these traits?

Answer: Dominant just means that when the gene is present, it will show. It does not mean that most people have the gene. If very few people have the gene for six-fingers, then the gene will not be passed to very many people. It is important in a population to talk about the *number* of the gene in the population or *gene pool.*

2. A certain dominant gene, Z, causes a deadly disease. People with this disease usually die before age 20. Do you think this gene will become common in the gene pool? Why or why not?

Answer: It will probably not become very common. This is because the people with the gene probably die before they have children. Thus, the gene will rarely be passed on.

3. The dominant gene W also causes a deadly disease. People with this disease usually develop symptoms around age 45 and die by age 50. Do you think this gene will become common in the gene pool? Why or why not?

Answer: It may. Since the people with the gene are not sick until they are older, they have probably had children and passed the gene on to the children before they die. How common it becomes depends on how many children the infected people have.

BLOOD TYPES

There are three types of genes for blood type. I^A and I^B are codominant. I^O is recessive. Below are possible genotypes and the blood type for each.

I^AI^A=Type A
I^AI^O=Type A
I^BI^B=Type B
I^BI^O=Type B
I^AI^B=Type AB
I^OI^O=Type O

1. Here are the blood types of two mothers, two babies, and two fathers. See if you can match the babies with the right parents.

Mother1: A	Mother 2: AB
Father1: B	Father 2: O

Babies: O and B

Answer: Baby O goes with Mother1 and Father 1.
Baby B goes with Mother 2 and Father 2.

2. You are a veterinarian. Mr. James and Ms. Crowley come to you with a problem. Mr. James' horse just gave birth to a foal. He sold the foal for $100,000. Ms. Crowley claims her horse was the father of the foal. Ms. Crowley wants half the money. Below are the blood types of the foal, the mother, and Ms. Crowley's horse. Does Ms. Crowley have a right to the money?

First, fill in the possible genotypes for each horse.

	Blood Types	Possible Genotypes
Mother horse:	A	**I^AI^A or I^AI^O**
Foal:	O	**I^OI^O**
Ms. Crowley's horse:	AB	**I^AI^B**

Could Ms. Crowley's horse be the father?

Answer: No. Ms. Crowley's horse does not have the I^O gene.

Can you know for sure what the mother's genotype is by looking at the baby's blood type?

Answer: Yes. She must be heterozygous, since the baby has the I^O gene.

CO-DOMINANCE

Petunias are plants with big, colorful flowers. You have a red-flowered petunia and a white-flowered petunia. You know that they are both homozygous. You also know that red (C^R) and white (C^W) are co-dominant. You cross-pollinate the red and white plants.

A) What are the genotype and phenotype of the offspring?
ANSWER: The offspring must be C^RC^W. Since the genes are codominant, both phenotypes show. The flowers would be pink.

B) Now you cross two of the offspring plants. Draw a Punnett Square to find the genotypes and phenotypes of the offspring.

Gametes: **C^R or C^W for both plants**

	C^R	C^W
C^R	C^RC^R	C^RC^W
C^W	C^WC^R	C^WC^W

C) How many of the offspring are white?
Answer: 1/4

D) How many of the offspring are red?
Answer: 1/4

E) Are any other colors possible?
Answer: Yes. 1/2 should be pink. (Pink is a combination of red and white.)

SEX-LINKED TRAITS

1. A man has a gene for a dominant trait on his X chromosome.

a) Can he pass the gene to his daughters? If so, what proportion of his daughters will show the trait?
Answer: Yes, he can pass the gene to his daughters. All of his daughters would show the trait since the man only has one X chromosome and the trait is dominant.

b) Can he pass the gene to his sons?
Answer: No. The father does not give an X chromosome to the son.

c) Does the man show the trait?
Answer: Yes, since the man only has 1 X chromosome, and therefore only one gene.

d) Can his daughters pass the trait to *their* sons or daughters?
Answer: Yes. His daughters can pass the gene to their sons and daughters. About half of the children should get the gene.

HEMOPHILIA

Hemophilia is a disease in which blood does not clot properly. Hemophilia is caused by a recessive gene carried on the X chromosome. Examine the following four marriages. Answer the questions that follow.

a) **Hemophiliac man** marries **Hemophiliac Female**

b) **Hemophiliac man** marries **Normal Female**

c) **Normal man** marries **Hemophiliac Female**

d) **Norman man** marries **Carrier Female**

1. Which marriage would produce the most hemophiliac children?
Answer: a) They are both homozygous recessive.

2. Which marriage would produce the most non-hemophiliac children?
Answer: b) None of the children would be hemophiliacs. Some of the daughters would be carriers.

3. Could couple c) produce normal boys?
Answer: No. The mother only has X chromosomes with the trait.

4. Could couple c) produce hemophiliac daughters?
Answer: No. The father cannot have the gene, since he is normal. Therefore, the daughters would either be normal or carriers.

5. Why can't a man be a carrier?
Answer: A man only has one X chromosome. Therefore, if he has the gene, he will show the trait. He will be a hemophiliac. If he does not have the gene, he cannot pass it to his children. Thus, he cannot be a carrier.

ECOLOGY

THE WATER CYCLE

Answer these questions about the water cycle.

1. a) How do animals remove water from the water cycle?
Answer: Animals drink water and use it in body processes.

b) Why is water important for animals? List the body systems that use water to function.
Answer: Animals need water for many body processes. The digestive, circulatory, excretory, and respiratory systems all use water.

c) How do animals put water back into the water cycle?
Answer: Animals return water in urine, feces, sweat, and exhaled air.

2. a) Name one important way plants use water. **Answer: photosynthesis**

b) How do plants put water back into the water cycle?
Answer: Plants lose water through their leaves, etc.

CYCLES IN THE ENVIRONMENT

1. Choose the correct answer.
   Why do plants need bacteria to change nitrogen to nitrate?
   A. Nitrogen is not available in the air
   B. Plants cannot use nitrogen in the air

2. In plants:
   What process gives off CO_2 **respiration**
   What process uses CO_2 **photosynthesis**
   What process uses O_2 **respiration**
   What process gives off O_2 **photosynthesis**

3. Name 2 things that plants provide to the environment. (Hint: Both are products of photosynthesis.)
   Answer: oxygen and sugar

4. Think about the nitrogen cycle, the water cycle, and the O_2 - CO_2 cycle.

   a) Why is it important that these systems are cycles?

Answer: So that the substances may be continually reused.

   b) What would happen if they were one-way instead of a cycle?

Answer: If they were not cycles, the supply of the substance (water, nitrogen, oxygen) would run out.

   c) If the systems were one-way, what would be necessary to keep the ecosystem from dying?

Answer: Something would have to keep adding the substance to the environment.

   d) Is energy used in a cycle? If not, then how does life continue? Where does new energy come from?

Answer: No. New energy is constantly added to the environment. The sun provides this energy.

ENERGY CHAIN

Rewrite the following things in the proper order for an energy chain.

Plants

Secondary consumers

Decomposers

Primary consumers

Sun Energy

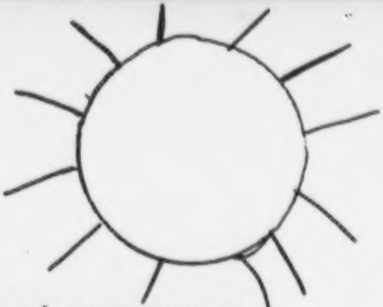
Answer:
- **Sun Energy**
- **Producers**
- **Primary Consumers**
- **Secondary Consumers**
- **Decomposers**

---

1. Choose the organism that contains the greatest amount of original food energy.
    A. Primary consumer
    B. Secondary Consumer
    [✓ C.] Producer

FOOD CHAINS

Arrange these animals into a food chain.



grass
cow
human

human ________ **secondary consumer**

cow ________ **primary consumer**

grass ________ **producer** ←

Now go back and match each of the following terms with one of the organisms.

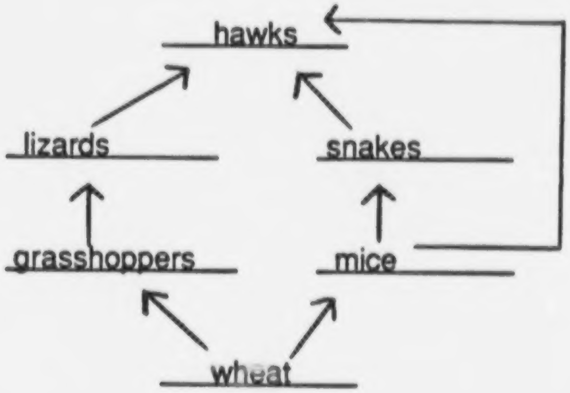
producer
primary consumer
secondary consumer

Draw in the primary energy source for this system and draw an arrow to the organism that utilizes the energy.

FOOD WEBS

Arrange these organisms into a food web using the spaces below. Draw arrows from prey to predator.

wheat
grasshoppers
snakes
mice
hawks
lizards



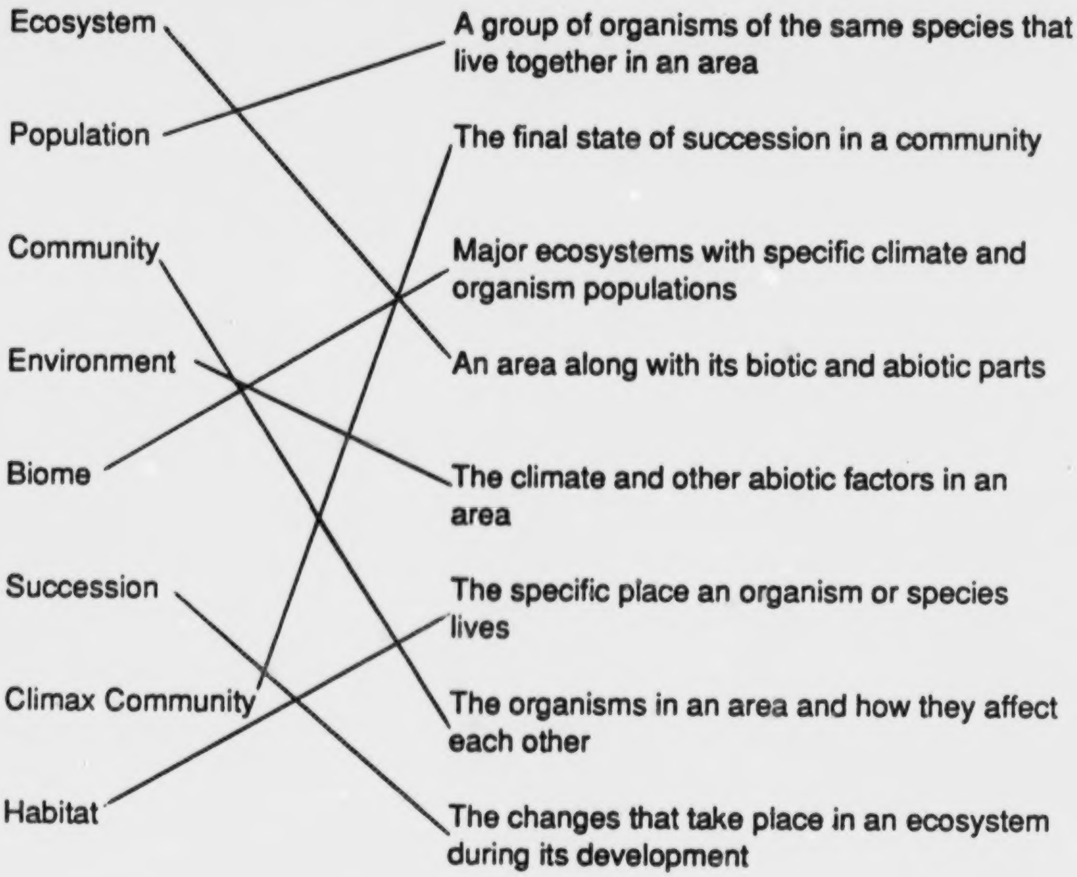
1. What controls the size of the population of the top secondary consumer in a food web?
Answer: The population size of the top secondary consumer cannot get too large because its food supply is limited.

2. Did any consumer eat more than one item in the food web? Which one?
Answer: Yes. The hawk ate the lizards, snakes, and mice.

3. Was any organism eaten by more than one predator? Which organisms?
Answer: Yes. The mice were eaten by the snakes and the hawks.

MATCHING

Match the words in the left column with the correct definition in the right column.



Ecosystem	A group of organisms of the same species that live together in an area
Population	The final state of succession in a community
Community	Major ecosystems with specific climate and organism populations
Environment	An area along with its biotic and abiotic parts
Biome	The climate and other abiotic factors in an area
Succession	The specific place an organism or species lives
Climax Community	The organisms in an area and how they affect each other
Habitat	The changes that take place in an ecosystem during its development

RELATIONSHIPS

1. Barnacles are small mollusks that attach to a surface in the ocean and then filter food from the water. Barnacles often attach to the sides of whales. The whales are not harmed by the barnacles. This kind of relationship is called Commensalism.

2. A tick is a small animal that attaches to dogs (and other animals). The tick feeds on the dog's blood. The tick can cause disease and discomfort to the dog. This kind of relationship is called Parasitism.

3. Cleaner wrasse are fish that live near large fish. The cleaner wrasse eat small parasites off the skin of the large fish. The cleaner wrasse get food and are protected by the large fish. This kind of relationship is called Mutualism.

4. Parasites harm their hosts. However, usually the parasite does not cause death in the host or causes death very slowly. How does this benefit the parasite?

Answer: If the host dies, the parasite does not have a home or food supply anymore. Also, the parasite may be trapped inside the dead body. It is better for the parasite if the host lives.

5. Discuss the special reproductive needs of a parasite that lives inside another organism.
   a) Is reproduction likely to be sexual or asexual?
   b) If reproduction is sexual, are 1 or 2 organisms likely to be involved?
   c) Is it advantageous for the eggs to be ejected from the host? Why or why not?

Answer: The parasite may be sexual or asexual. If it is sexual, it has the problem of trying to find a mate. (It is possible, however, to have sexual reproduction with 1 organism supplying both the sperm and egg, but this is not as good.) It is unlikely that another parasite would be present in the same place so that mating could take place. Asexual would be easier. The organism must have some way of getting the fertilized eggs or developing parasites out of the host. If the offspring stayed in the same host, there would eventually be too much competition. If the offspring are ejected, they can find their own host.

POPULATIONS AND ECOSYSTEMS

1. a) Name at least three things organisms compete for in an ecosystem.
Answers: food, shelter, nesting sites, mates, water, territory, etc.

b) Do members of the same population compete with each other?
Answer: Yes. An organism must compete with the other members of the population for food, etc.

c) Do different populations compete with each other?
Answer: Yes.

2. **You are the wildlife manager for a large lake. You want to increase the number of trout in the lake.**

a) What could you add to the lake to increase the number of trout?
Answer: You could add extra food, oxygen. (Other answers are OK)

b) What could you take out of the lake to increase the number of trout?
Answer: You could remove predators, wastes. (Other answers are OK)

c) Name some things that would limit the number of trout.
Answer: The size of the lake, the available oxygen, the number of egg-laying sites, etc.

CHANGING ECOSYSTEMS

1. You want to build a dam on a river to stop the water flow. You know that this will greatly change the ecosystem. You do a careful study to see how the change will affect the community.

   a) Why is this important?

Answer: It is important to make sure you do not destroy ecosystems. Since ecosystems are webs, even small changes could greatly effect the environment.

Your study reveals that the new dam will destroy the habitat of a small snail that lives in the river.

b) Is this important?

c) How could this affect the rest of the ecosystem?

Answer: It might be very important. If the snail is an important link in the food web, removing the snail could greatly effect other organisms. The other organisms would no longer have any food. Then the second organism might die off. This would leave no food for the organism that preyed on it, etc.

d) What process allows species to survive in a changing environment?

Answer: Adaptation

1. Turn to page 59 in the unit on bacteria. Read question 2.

   a) Is this graph relevant to populations other than bacteria?

Answer: Yes. It represents the growth rates of many organisms.

   b) What is the resource that allows the beginning growth (the A part of the graph)?

Answer: There is lots of food and room. Birth greatly outnumbers death.

   c) What are the limiting factors that cause the reduced growth rate of section B of the graph?

Answer: As more animals are born, the amount of food, etc., for each organism decreases.

   d) What limiting factors are causing the increased death rate of the population in section C of the graph?

Answer: Competition between members of the population. The environment can only support a certain number of individuals. When that number is reached, the rest die.

2. There are two types of factors that affect the growth rate of a population. One type are called **Density Dependent Factors**. The second type are called **Density Independent Factors**. These "factors" are things in the environment that affect how many animals live, reproduce, grow, and die. **Can you guess what each of these labels (Density dependent and density independent) means?** (Use the dictionary to look up density if you don't know what it means.)

Answer: Density Dependent means how the factor affects the population depends on how big the population is. Density Independent means how the factor affects the population does *not* depend on how big the population is.

Put the following factors under the proper category.

food supply
precipitation
number of predators
forest fire
temperature
quality of available water
number of hiding places
number of places to build a nest

Density Dependent Factors	Density Independent Factors
food supply	temperature
hiding places	precipitation
nest sites	forest fire
number of predators	quality of available water

1. How could soil erosion on a hill above a lake affect the succession of the lake community? How would the erosion affect the succession of a land community?

Answer: Erosion would cause the lake to fill with dirt faster. However, it would also make it hard for plants to grow on the land around the lake because the soil is eroding.

Erosion would probably slow the succession of a land community and perhaps keep it from progressing. The loss of dirt would keep plants from growing well.

2. Which appears first in a new community, primary consumers, secondary consumers, or producers? Why?

Answer: Producers must appear first. Without producers, the food chain would not work.

3. **"The larger the animal, the more likely it is that humans can control or eliminate it."** Do you think this sentence is true? Why or why not?

Answers will vary.

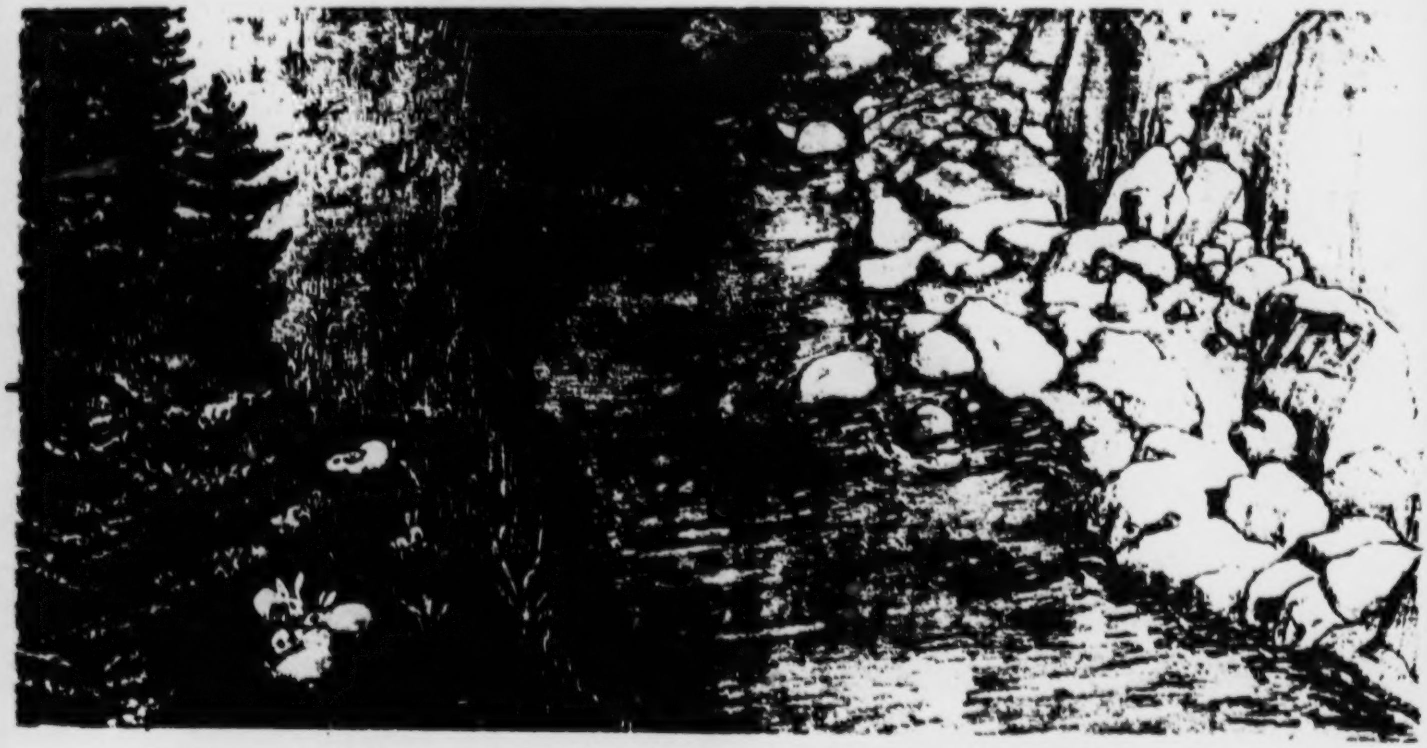
4. a) Would adaptation and selection occur in a competition-free environment?

Answer: No. There would be no basis for selection if there were no competition. You must have competition in order for there to be a "fittest" organism.

b) Would variation occur?

Answer: Yes. Variation is a product of gene mutation. It is not related to competition.

WHERE DO ANIMALS LIVE?



In this ecosystem, a certain species of rabbit is only found on the left side of the river. You think this is because the rabbits cannot cross the river. **How could you test this hypothesis?**

In fact, you find that the rabbits can cross the river, but still no populations of rabbits are found living on the other side of the river. What else might be keeping the rabbits from colonizing the other side of the river?
Your partner has some information about the ecosystem. Ask your partner questions to get information about the ecosystem. Using the information, propose another hypothesis to explain the absence of rabbits from the other side of the river.
Tutor: Below is information about the two sides of the river. Use this information to answer your partner's questions.

	Left Side	Right Side
Temperature (average)	65°	65°
Rainfall	2 inches/month	1.9 inches/month
Food available?	Yes	Yes
Predators present?	No	Yes
Hiding places?	Yes	No

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ENGLISH SKILLS FOR LIFE SCIENCES:

PROBLEM SOLVING IN BIOLOGY

Center for Language Education and Research

Center for Applied Linguistics

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SCIENCE METHODS

SCIENCE METHODS

How does "science" happen? A scientific advance always begins with an ***observation***. Someone notices that gases expand when they are heated. You notice that when you touch something hot, your hand pulls away from the heat source even before you realize it is hot.

How do these things happen? Using knowledge of the systems or processes involved, the scientist makes guesses about the cause. A guess is called a ***hypothesis***. Some of the guesses may be unusual or unbelievable. At this stage it is best to think creatively and freely.

Next, the scientist chooses the hypothesis that seems most likely to be true. The scientist conducts ***experiments*** to test the hypothesis. The results of the experiment may lead the scientist to drop a hypothesis. Or the results may support the hypothesis. If enough support for the hypothesis is found, the hypothesis is called a ***theory***. Many experiments must confirm the hypothesis before it becomes a theory. A theory explains an observation in terms of things that are already known. A theory also ***predicts*** what will happen under given circumstances. A scientific theory must always be able to make predictions.

Theories are not absolute. They must be modified as new information is obtained. A theory that is accepted may later be rejected because of new information.

A scientific ***law*** is a statement about an observation. Laws describe things that have been observed always to be true. For example, it is a law that when you increase the temperature of a gas, either its volume or the pressure it exerts will increase. There is nothing about *why* included in the law.

SOLVING SCIENCE PROBLEMS

When you are trying to solve a science problem it is helpful to follow certain steps. 1) First, completely define the situation, making a list of everything you know (measurements, things involved, etc.). 2) List the steps in the process being studied. 3) List all the systems, organs, or structures that might be involved in the process. 4) Next, think of all the explanations you can. Be creative — don't rule out any ideas at this stage. Just write down all your ideas. 5) Later, check your ideas and decide if you think they are possible. Choose the idea that seems the most likely. 6) Go back to your list of what you observed. Try to explain what is happening using the idea you came up with.

EXPERIMENTING

When you conduct a scientific experiment, there are certain guidelines you should follow. 1) First, state the hypothesis you wish to test. For example, "*Red light makes plants grow less than normal light.*" 2) Second, make a prediction about what will happen in the experiment if your hypothesis is true. Predictions are usually stated with "If....., then....". Here the prediction would be "*If you shine red light on plants, they will grow less.*" 3) Third, design and set up the experiment, identifying an experimental group and a control group. The ***experimental group*** is the group of things you are using in the experiment. For example, if you are experimenting to see how red light affects plants, the plants you shine red light on are the experimental group. It is important to always have a second group. The second group is the ***control group***. The control group does not receive experimental treatment. In the example above, the control group would be plants that are grown in normal light. You can compare the experimental group to the control group. During the experiment, you observe to see what happens. This is called ***data collection***. The ***result*** of the experiment is the final outcome. For example, *the plants in red light grew less than the normal plants* is a result. Finally, after the experiment, you look at the results to see if they match your prediction. A ***conclusion*** is what you believe after examining the results. *Red light makes plants grow less* is a conclusion.

MATCHING

Match the experimental terms on the left with the examples on the right.

hypothesis

control group

experimental group

data collection

results

conclusion

3 of the plants watered with salt water died. The other two only grew 1.2 cm. None of the plants watered with tap water died. All these plants grew at least 2.7 cm.

Salt water is probably worse for plants than regular tap water.

Every day I measure all the plants. Also, I check to see whether any of them have died.

Plants watered with regular tap water

Salt water is worse for plants than regular tap water. Plants that are watered with salt water have a better chance of dying and don't grow as much as plants watered with tap water.

Plants watered with salt water

ARISTOTLE

Aristotle was a great Greek philosopher who lived around 350 B.C. To learn about the horse's anatomy, Aristotle dissected a dead horse. When he cut open the heart, he found a bone-like structure in one chamber. In writing his conclusions from the dissection, Aristotle stated that all horses have bones in their heart. For hundreds of years, textbooks stated that horses have bones in their hearts. Today, scientists do not believe that horses have bones in their heart.

A) How did Aristotle make this mistake?

B) What did he do wrong?

C) How could he have avoided his mistake?

D) Did he follow the method for experimenting given in this unit?

EXPERIMENTING

Dr. King conducted a study to see how plants respond to a new soil that contains special chemicals. Dr. King grew 20 plants in the special soil and measured their growth every day for 2 months. At the end of 2 months, all of the plants had grown over 3 feet. Dr. King concluded that the special soil caused plants to grow quickly.

A) What is wrong with this experiment?

B) How would you improve it?

C) Was Dr. King's conclusion right?

SPONTANEOUS GENERATION

People have often observed that rotten meat and trash often seem to "produce" flies. The baby flies seem to appear from the trash. Some people believe the flies are being born from the trash (the trash is the "parent"). This is called *spontaneous generation*.

A) Give your own hypothesis of where the flies are coming from.

B) Design an experiment to test your hypothesis.

ANTHRAX

In the 1870's, a scientist named Robert Koch was investigating a disease in cows called anthrax. In examining blood from sick cows, he found that all the sick cows had small rod-shaped cells in their blood. Dr. Koch believed that these cells were causing the disease.

A) How could he check his hypothesis?

B) Outline a procedure for determining if these cells caused the disease. Make sure that your procedure allows you to make predictions and observe results.

AFFIXES

AFFIXES

In science, there are many new words to learn. A lot of the words seem very long or complicated. They are often hard to pronounce. This can make learning science seem very difficult. But when you look at them closely, you will see that the words are not really that difficult. Many of the words in science use ***affixes.*** Affixes are parts of words that have specific meanings. Affixes can be at the beginning of the word (**prefixes**), at the end of the word (**suffixes**), or in the middle of a word. The part of the word that carries the primary meaning is called the ***root*** or ***stem***. The same affix may be used in many different words. If you know what the affix means, you can often figure out what the word means.

For example, in the word *biology*, ***bio-*** is a root and ***ology*** is a suffix. Bio means life or living. *Biology* is the study of life; a *biography* is a book about someone's life; *biochemistry* is the study of the chemistry of living things. Knowing what *bio-* means gives you a clue to the meaning of many other words. This unit lists some common affixes and their meanings. There are also some exercises to give you practice in using your knowledge of affixes.

AFFIX	MEANING
a —	not; without
anti —	opposite; against
aqua —	water
bi —	twice or two
bio —	life
cardia —	heart
centi —	hundred
com —	together
cyto —	relating to the cell
cycl —	round
derma —	skin
di —	two
diplo —	double
dis —	apart; not
duo —	two, twice
e —	without
endo —	inside
epi —	over; on top of
eu —	good; truly
ex —	without; lacking
exo —	outside

gastr — stomach; belly

geo — earth

gyn — woman; female

hab — have; hold; occupy

halo — salt

haplo — single

hemi — half

hetero — different

homo — same

hydro — water

hyper — over; above

hypo — under; below; lower

in — not; without

inter — between

intra — within

iso — equal

lepid — scale

lun — moon

macro — large; long

mega — big; great

meso — middle

meter — measurer

micro —	small
milli —	thousand
mono —	one; single
neo —	new; young
neur —	nerve
non —	not
ology —	the study of
ovi —	egg
patho —	relating to disease; suffering
ped —	foot
phil —	love
photo —	light
phyt —	plant
pod —	foot
poly —	many
pre —	before
pseudo —	false
pter —	wing; feather
ren —	kidney
retro —	backward
semi —	half
sol —	sun

sub —	under; after
super —	above; over
sym —	together
tel —	far away
terra —	land; earth
therm —	heat
tri —	three
uni —	one
zo —	animal

MATCHING

Sometimes knowing the affixes can make you figure out the meaning of even very outrageous looking words. How many can you figure out? Match each word on the left with the correct definition on the right. Each word contains an affix. Look the affixes up in the glossary if you are not sure of the meaning.

speedometer	Movement of an organism in response to heat
phototaxis	a person trained to live in underwater "homes" and conduct scientific research
thermotaxis	the area which an organism usually occupies
telemetry	a device that measures speed
aquanaut	movement of an organism in response to light
habitat	inflammation of the skin
retrograde	the measurement of data from far away places using remote control
dermatitis	moving backward; retreating

MATCHING

Sometimes knowing the affixes can make you figure out the meaning of even very outrageous looking words. How many can you figure out? Match each word on the left with the correct definition on the right. Each word contains an affix. Look the affixes up in the glossary if you are not sure of the meaning.

sympetalous

macrocyte

halophyte

epithelium

pseudomorph

neonate

mesophyll

a plant that grows in salty soil

the middle layer of tissue in a leaf

having petals that are fused or joined together

a membrane forming the outer covering of an animal body

a newborn child

a mineral showing the form of another mineral; false form

an unusually large red blood cell

SIZE

Circle the word in each group that is probably the largest or the one that contains the most of something.

1. bicycle
   tricycle
   unicycle
   hemicycle

2. haploid
   diploid

3. monopode
   centipede
   millipede
   tripod
   biped

4. macroscopic
   microscopic

5. microspore
   megaspore

6. polygamous
   bigamous
   monogamous

7. hyperacidic
   hypoacidic

8. What do all the items in number 1 have in common?

9. What do all the items in number 3 have in common?

OPPOSITES

1. Which word describes a place closest to the earth?
   a) sublunar
   b) superlunar

2. A skeleton is the hard structure that provides support to an organism (like bones). What is the difference between an ***endoskeleton*** and an ***exoskeleton*** ?

3. What is the difference between ***interstate*** and ***intrastate***?

4. Which word describes things happening inside one cell?
   a) intercellular
   b) intracellular

What does the word you did not choose mean?

GUESSING MEANINGS

1. Each word below describes a person who studies something special. See if you can guess what each person studies. The affixes in each word give you a clue.

Dermatologist ____________________

Cytologist ____________________

Pathologist ____________________

Biologist ____________________

Geologist ____________________

Cardiologist ____________________

Gastrologist ____________________

Neurologist ____________________

Podiatrist ____________________

2. Below are the scientific games of some insects. Try to describe the wings of each insect by figuring out what the name means. Can you guess what insects each name describes?

Lepidoptera

Dermaptera

Isoptera

Diptera

Homoptera

MEASUREMENT

MEASUREMENT

1. Match each symbol on the left to the prefix on the right that it stands for.

c
d
m
k

milli-
centi-
kilo-
deci-

2. Match each type of measurement on the left with its unit.

length
mass
time
temperature
volume

kilogram
Celsius °
meter
liter
second

3. Match each prefix on the left with its multiplier.

kilo-
deci-
centi-
milli-

.1
.001
1000
.01

4. Match each unit on the left with its symbol.

millimeter	m
centimeter	mg
meter	mL
kilometer	km
milliliter	mm
liter	g
milligram	kg
gram	cm
kilogram	L

CONVERTING MEASUREMENTS

To convert from one unit to another in the metric system, you need to know ***base units*** and what the prefixes mean. The process is called ***conversion***. The base units are standard units. Other units are described in terms of base units. The ***prefixes*** on a unit name tells you how a unit compares with a base unit. For example, a milliliter is one thousandth as big as a liter. The *milli-* part means *one thousandth*. So to make a liter, you would need one thousand milliliters.

Here are some examples of conversion ih the metric system.

A. **111 meters is how many kilometers?**
Kilo- means *a thousand*; one kilometer is a thousand times bigger than a meter. Another way to say this is one meter is one thousandth as big as a kilometer. So to get the answer, multiply 111 meters by one thousandth (.001). You get .111 Km.

B. **38 centimeters is how many decimeters?**
Centi- means *a hundredth* and *deci-* means *a tenth*. So a centimeter is a hundredth as big as a meter and a decimeter is a tenth as big as a meter. That means a decimeter is ten times bigger than a centimeter. Or you could say that a centimeter is one tenth the size of a decimeter. So to get the answer, multiply 38 centimeters by one tenth (.1). You get 3.8 decimeters.

C. **.092 liters is how many milliliters?**
Milli- means *one thousandth*. That means a milliliter is equal to one thousandth of a liter. So if it takes a thousand milliliters to make a liter, multiply .092 by a thousand to get the answer. The answer is 92 mL.

CONVERSION

1. 4 centimeters = ________ meters
2. .18 meters = ________ millimeters
3. 3010 millimeters = ________ centimeters
4. 7.5 meters = ________ centimeters
5. 222 centimeters = ________ millimeters
6. 46 millimeters = ________ meters
7. 71.3 centimeters = ________ meters
8. 4900 millimeters = ________ meters
9. 5 liters = ________ milliliters
10. 60.7 milliliters = ________ liters
11. 840 milliliters = ________ liters
12. .039 liters = ________ milliliters
13. 95 grams = ________ kilograms
14. .058 kilograms = ________ milligrams
15. 67 milligrams = ________ grams
16. 8.1 kilograms = ________ grams
17. 32 grams = ________ milligrams
18. 7400 milligrams = ________ kilograms
19. 290 grams = ________ kilograms
20. 654,321 milligrams = ________ kilograms

CLASSIFICATION

CLASSIFICATION

List some things that are not alive and explain how you know they are not alive.

NOT ALIVE

List some things that are alive and explain how you know they are alive.

ALIVE

What is the difference between the things you listed and things that are not alive? Turn the page if you are having difficulty here. The next pages describe living things.

WHAT MAKES SOMETHING ALIVE?

Biologists (scientists who study life) have observed many different kinds of living things. By comparing the characteristics of all of these living things, biologists have learned that all living things do certain things. These things that all living things do are called ***life functions.*** The following chart lists the eight life functions, a definition for each one, the importance of each one to life, and the processes that are involved in performing that life function.

Name of Life Function	Definition of Life Function	Importance of Life Function	Activities Involved in Life Function
1. Nutrition (eating)	The process by which a living thing takes food from its environment and uses it for energy and growth	Makes it possible for the living thing to grow and develop	*ingestion* - getting and consuming the food *digestion* - changing the food into a form the body can use
2. Transport (moving substances)	The process by which substances are moved from place to place within the body	Makes it possible for substances to get to the parts of the body that can use them	*diffusion* - movement to distribute a substance equally *circulation* - the movement of fluid through the body
3. Respiration (breathing)	The process of bringing in oxygen and using it for metabolic processes	Makes it possible for food to be converted to energy	*breathing* - the pumping of oxygen into the body *cellular respiration* - the chemical process of getting energy from food by using oxygen or other chemicals
4. Excretion (waste removal)	The process by which waste (unnecessary or harmful substances) is released by the body	Prevents harmful waste products (such as ammonia) from "poisoning" the body	Excretory cells or organs remove waste from the body and expel it into the environment

5. Synthesis (making substances)	The process by which small molecules are built into larger ones	Makes it possible for the body to make enzymes and other complex chemicals the body needs	*Ribosomes* - make proteins in the cells
6. Regulation (controlling the life functions)	The process by which the life functions of a living thing are controlled	Makes sure that the body does the right thing at the right time	*Nervous System* - controls movement and the body's awareness of itself *Endocrine System* - makes hormones which trigger many body activities
7. Growth	The process by which the size and number of cells increase	Allows the living thing to get larger and mature (become an adult)	*Mitosis* - a type of cell division which makes new cells
8. Reproduction	The process by which new living things are made by existing ones	Prevents living things from becoming extinct (disappearing from the earth)	

WHAT IS NECESSARY FOR LIFE?

Put a check mark next to all the processes that are ***necessary*** for life.

____ Eating

____ Transportation of substances in the body

____ Respiration (breathing)

____ Seeing

____ Removing waste

____ Body movement

____ Regulation of body functions

____ Growth

____ Reproduction

____ Hearing

____ Erosion

The Classification of Living Things

All living things share the characteristic of being alive--that is, they carry out the life functions of eating, growing, developing, using energy, and reproducing. What other characteristics do living things have in common? The answer depends on which living things you compare. A cat and a dog have many additional characteristics in common; a cat and a rose do not share additional characteristics. A rose has more in common with an oak tree than with a cat. Dogs, cats, roses, and oak trees fall into two different groups of living things called **animals** and **plants**. The difference between them is known as a **group difference**.

Biologists often need to talk about group differences. To make these discussions easier, they have developed a system of classification for living things. This ***classification system*** does two important things: 1) it groups living things by their similarities and differences and 2) it gives a different name to every living thing on the earth so biologists can avoid the problem of having two plants or animals with the same name.

This classification system has 7 main levels. They are listed below.
Kingdom
Phylum
Class
Order
Family
Genus
Species

It is a ***hierarchical*** system, which means that these 7 levels must always stay in the order given here. Each level includes all the levels below it. The **kingdom** includes the 6 lower levels--**phylum, class, order, family, genus, and species**. The **phylum** includes the 5 lower levels--**class, order, family, genus, and species**; and so on for all the levels. Each level gets its name from the groups within it--the level **kingdom** contains 5 groups called **kingdoms**; the level **order** contains different groups called **orders**, etc.

An easy way to remember the correct order of the groups is to memorize the sentence below. The first letter of each word in the sentence is the same as the first letter in one of the groups in the classfication system.

Keep	potato	chips	out	for	good	snacks.
Kingdom	phylum	class	order	family	genus	species

WHICH ARE ALIKE?

Read the following pairs of statements. Choose the statement that describes the organisms that would have the most in common. **Hint:** Those things that are further down the classification chart are more alike.

Which would have the most in common,

1. 2 organisms in the same phylum ___
or 2 organisms in the same genus? ___

2. 2 organisms in the same family ___
2 organisms in the same order ___

3. 2 organisms in the same species ___
2 organisms in the same genus ___

4. 2 organisms in the same species ___
2 organisms in the same phylum? ___

5. 2 organisms in the same subphylum ___
2 organisms in the same phylum ___

At which level (kingdom, etc.) would the members of that group have the most in common?

At which level would the members of that group have the least in common?

WHICH HAS THE MOST?

Circle the group in each list which probably contains the most organisms.

1. class
   order
2. genus
   family
   species
3. phylum
   class
4. class
   subclass
   order
5. family
   superorder
   order
6. superclass
   phylum
   kingdom
7. subspecies
   genus
   species
8. kingdom
   species

Can you think of a situation where an order would contain more organisms than a class?

WHAT MAKES A SPECIES?

Put a check mark by the statements below that are true for all members of a species.

____ Can produce fertile offspring

____ Are the same color

____ Belong to different families

____ Live in the same area

____ Look identical

____ Belong to the same genus

____ Are animals

____ Have many of the same characteristics

List the statements you did not check. Next to each, tell why it is not always true of members of the same species.

THE 5 KINGDOMS

Match the kingdom name on the left with the correct description on the right.

Protista

Monera

Animalia

Fungi

Plantae

Single-celled organisms that do not have a nucleus or organelles. They have circular chromosomes.

Many-celled organisms. The cells have a nucleus and organelles, sometimes including chloroplasts. Each cell has a cell wall. These organisms can usually make their own food.

Single-celled organisms that have a nucleus and organelles. They have straight chromosomes inside a nucleus.

Many-celled organisms. The cells have a nucleus and organelles. Cells do not have a cell wall. These organisms usually cannot make their own food.

Single- or many-celled organisms. The cells have a nucleus and organelles. These organisms get their nutrition by decomposing organic matter.

(Organelles are small structures inside a cell. Refer to the unit on The Cell for information about organelles and other cell parts.)

DICHOTOMOUS KEYS

A ***dichotomous key*** is a guide for identifying and classifying living things. Dichotomous keys can be made for all levels in the classification system.

Each key consists of several pairs of statements. The first statement in each pair describes one characteristic, and the second statement in the pair describes the *opposite* characteristic. Each statement always describes the same structure on the organism (like the leaf of a plant).

Here are the steps for using a dichotomous key:

1. Select the organism you want to identify.
2. Start with pair #1.
3. Read both statements in the pair.
4. Select the statement that best describes your organism.
5. If the statement you chose is followed by a number, go to the pair that has that number. Repeat steps 3-5.
6. If the line you chose is followed by a name, you may stop. You have identified your organism.

A. Can you think of some situations where it would be helpful to identify an organism?

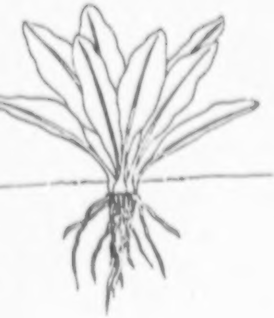
B. In what areas of biology do you think these keys are used?

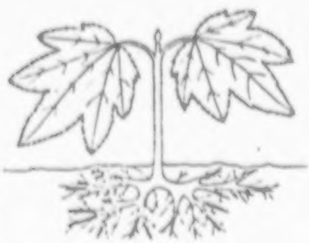
C. How is a key related to the classification of organisms?

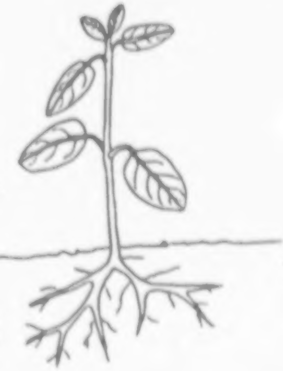
D. Why do you think this is called a "key"?

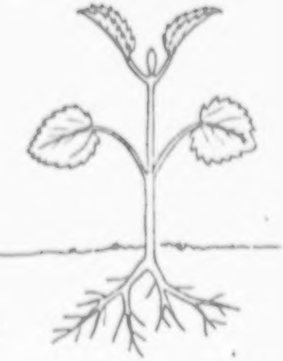
PRACTICE WITH A DICHOTOMOUS KEY

Below is an example of a dichotomous key. Use the key to identify the imaginary plants drawn below. Write the name for each organism next to the letter for each at the bottom of the page.


A


B


C


D

KEY TO IMAGINARY PLANTS

1a.	Has a stem	2 (go to pair #2)
1b.	Doesn't have a stem	Acaulescent
2a.	Leaves have serrated (rough) edges	3
2b.	Leaves have smooth (entire) edges	Entirata
3a.	Leaves are longer than 1 centimeter	Longus
3b.	Leaves are not longer than 1 centimeter	Minutae

Write the name of the organisms as you identified them using the key above.

A. ____________

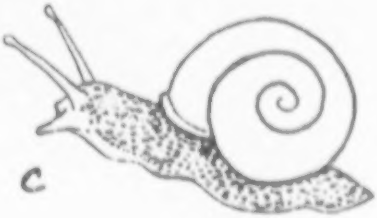
B. ____________

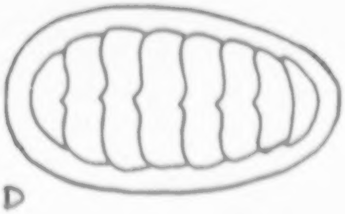
C. ____________

D. ____________

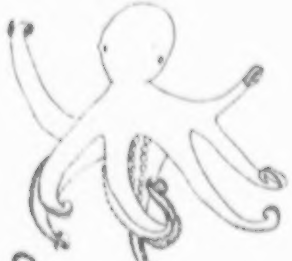
IDENTIFYING SOME MOLLUSKS

Using the key at the bottom of the page, identify the organisms that are drawn below.


C


D

A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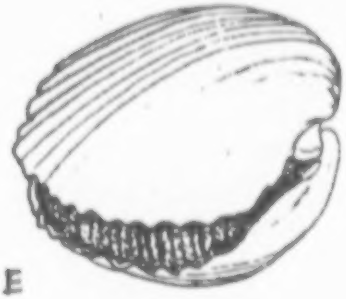

E

KEY TO THE CLASS OF SOME MOLLUSKS

1a. Has a shell 2
1b. Doesn't have a shell . . . . Cephalopoda
2a. Shell is in one piece. 4
2b. Shell is in more than one piece 3
3a. Shell is in two pieces . . . . Bivalvia
3b. Shell is in more than two pieces. . . . . Polyplacophora
4a. Shell is spiraled (twisted). . . . . .Gastropoda
4b. Shell is not spiraled . . . . .Scaphopoda

Write the class of the organism beside the appropriate letter.

A. ____________

B. ____________

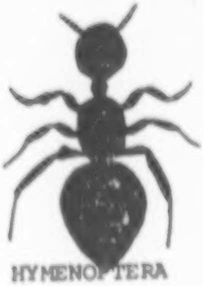
C. ____________

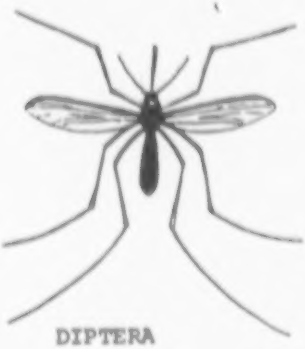
D. ____________

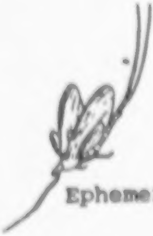
E. ____________

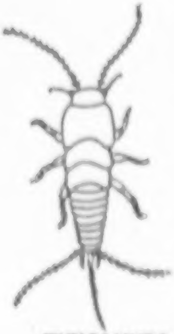
COMPLETE THE KEY

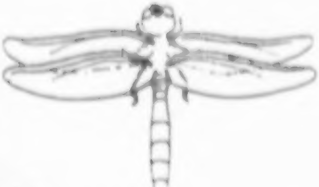
Below is an unfinished dichotomous key for the organisms drawn below. Fill in the blanks in the key using the information you are given and what you know about dichotomous keys.


HYMENOPTERA


DIPTERA


Ephemeroptera


THYSANURA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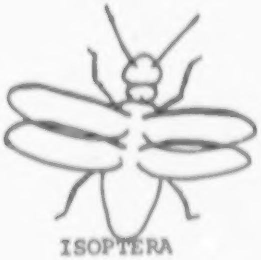
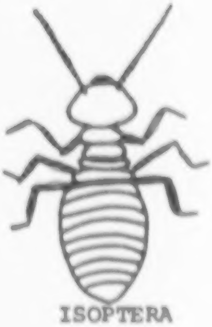

ISOPTERA


ISOPTERA

A KEY TO THE ORDER OF SOME INSECTS

1a. Has wings 2
1b. ________________ 5
2a. Has two wings . . . . ________
2b. Has four ______ 3
__ Wings are about the same size 4
3b. Wings are not ________________ . . . . ________
4a. Body is very thin . . . . ________
4b. ________________. . . . . .Isoptera
5a. Body white 6
5b. Body __________ . . . . .Hymenoptera
6a. Has 3 thin tails . . . . .Thysanura
6b. ________________. . . . . ________

WRITING A DICHOTOMOUS KEY

Now you write a dichotomous key using the characteristics of the organisms listed below. Pick the characteristics that will be the easiest to recognize and describe. You might use a characteristic more than once or you might not use a characteristic at all.

	Violet	Lily	Strawberry	Mint
Stems	herbaceous	herbaceous	herbaceous	herbaceous
Leaf type	compound	simple	compound	simple
Veins	net	parallel	net	net
Petal Color	purple	yellow	yellow	purple
Flowers symmetrical?	No	No	Yes	No

Were there any characteristics that you did not use? If so, which ones?

Is there more than one way to write this key? Why or why not?

A KEY TO THE KINGDOMS

Write a dichotomous key to distinguish the five kingdoms: Monera, Protista, Plantae, Fungi, and Animalia. Start by listing the characteristics that distinguish each kingdom. Some characteristics have been listed to get you started.

	Monera	Protista	Fungi	Plantae	Animalia
number of cells					
cell wall?					
nucleus?					

1a.
1b.
2a.
2b.
3a.
3b.
4a.
4b.
..
..
..
..

THE CELL

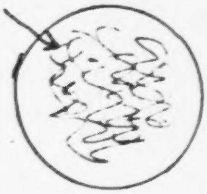
THE CELL

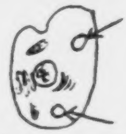
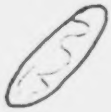
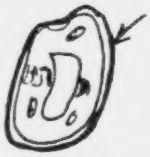
All organisms are made up of small units called ***cells***. Cells are also living things. They are the smallest living things. There are even some organisms that consist of only one cell! Plants and animals, however, have many cells. Everything that happens to an organism actually happens to a cell. And everything that an organism does is actually done by a cell. When you raise your hand, the cells in your brain send messages through the cells of your nervous system to the muscle cells in your arm and hand. The muscle cells cause your hand to be lifted.

An ***organism*** is a collection of cells that work together. Usually, each cell does a specific job for the organism that it is part of. Blood cells perform different functions from skin cells; brain cells perform different functions from muscle cells. But all cells have similar parts and carry on their processes in similar ways.

PARTS OF A CELL

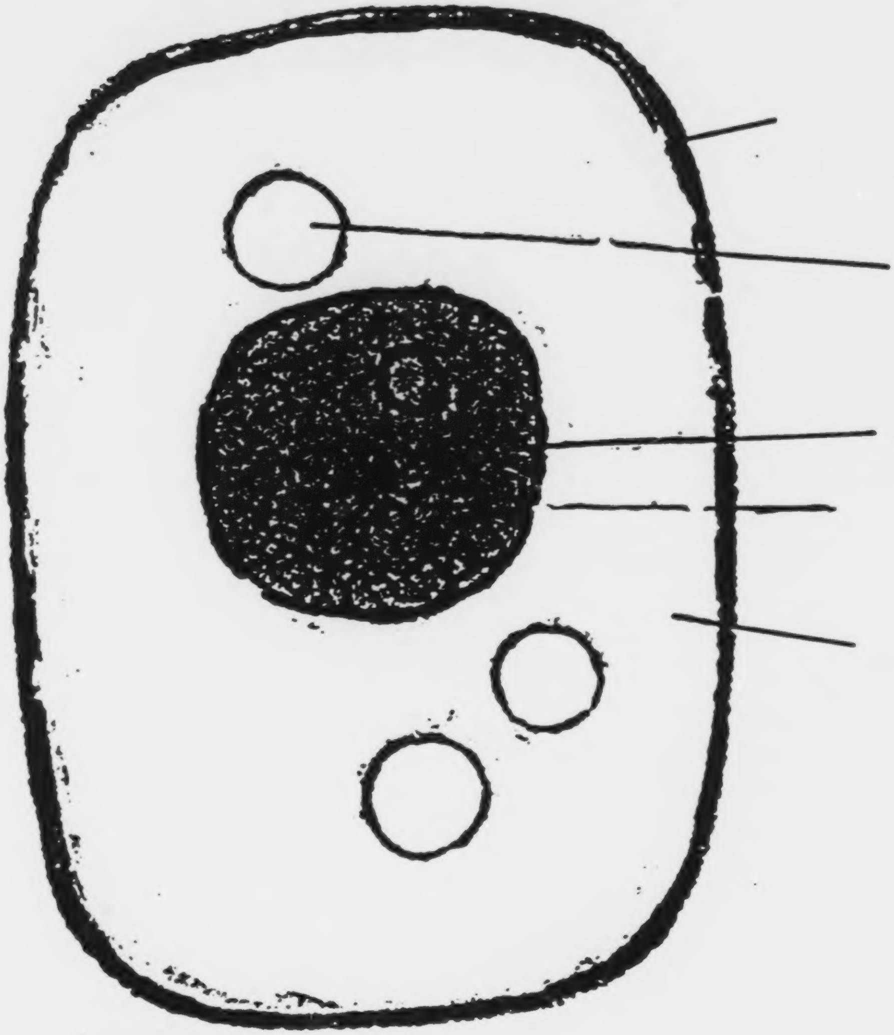
The following chart explains the structures within the cell. The first column gives the name of the cell part; the second column describes the cell function; and the third column provides an illustration of the part. Fill in the missing parts. You should use your book for help.

Name of Cell Part	Function	Drawing
cell membrane	the outer boundary or "skin" of a cell which controls the movement of substances (especially water) into and out of the cell.	
______________	the living material inside a cell. It is clear and gel-like.	
nucleus	An area inside the cell surrounded by the nuclear membrane. It contains the chromosomes and controls the cell's activities.	
______________	structures inside the nucleus that contain the genes of the cell. They tell the cell how to function and reproduce. They are long and thin like threads.	
nuclear membrane	______________ ______________ ______________	
endoplasmic reticulum	a system of tubes that moves substances throughout the cell	

Name of Cell Part	Function	Drawing
Golgi bodies	structures that store cell wastes and transport them to the cell membrane where they leave the cell	
ribosomes	structures that make proteins for use by the cell. Ribosomes are found throughout the cell, but they are often found on endoplasmic reticulum.	
vacuoles	____________________ ____________________ ____________________	
____________	the structure where cells carry out a complex chemical reaction (cellular respiration) that turns food into energy.	
Plant cells have 2 additional parts that animal cells do not have:		
cell wall	____________________ ____________________ ____________________ ____________________	
____________	structures that contain chlorophyll which use sunlight to make food for the plant.	

In the drawing below, label the indicated structures. Draw in the missing organelles.

Animal cell



Please add:

- Golgi bodies
- Endoplasmic reticulum
- Mitochondria
- Ribosomes

LIFE FUNCTIONS

Since cells are living things, they must carry out the essential life functions. In the space provided below, give the name of the cell parts that carry out each function listed. Look at the chart you just filled in for help.

Nutrition

Cell Respiration

Transportation

Synthesis

Excretion

Reproduction

BUILDING BLOCKS

Match each organic compound with the proper description.

Carbohydrates	Hydrogen, carbon, and oxygen. Used mostly for energy. (Sugars)
Lipids	Hydrogen, carbon, oxygen and nitrogen. Made of amino acids. Used for enzymes, hormones, etc.
Proteins	Complex organic compound (DNA & RNA) that carries hereditary information.
Nucleic Acid	Hydrogen, carbon, and oxygen. Used for energy and membrane construction.

OSMOSIS

A worm is weighed. Then it is placed in a bowl of water. The worm is taken out and weighed every 15 minutes. The results are given in the table below. From this information, decide whether the water in the bowl had a greater or lesser concentration of dissolved substances than the worm's body fluids.

Time:	0 minutes	15 minutes	30 minutes	45 minutes
Weight:	15 grams	14 grams	10 grams	6 grams

ORGANIZATION

Cells in many-celled organisms can all be alike. Very often, however, the cells are ***specialized***. All the cells are not alike. Each cell or group of cells does a specific job. This is called ***division of labor***. When cells which perform the same function are grouped together, they are called a ***tissue***. Several tissues which work together to perform a function are called an ***organ***. Several organs that interact to perform a function are called an ***organ system***.

For example, the cells that line the stomach are all alike. They secrete certain chemicals and perform other functions. These cells together are called a ***tissue***. The muscle cells that cover the outside of the stomach are responsible for moving the stomach. These cells are also a ***tissue***. All the tissues in the stomach work together to perform the function of digestion. Therefore the stomach is an ***organ***. The stomach is not the only organ that digests food. The esophagus and the intestines also help digest food. The esophagus and the intestines are also ***organs***. The esophagus, stomach, and intestines are organs that work together to perform digestion. These organs together are called the digestive ***system.***

WHAT IS MITOSIS?

All cells must copy themselves at some time during their life. New cells must be produced to take the place of cells that have died or have been lost (for example, you lose blood cells if you cut yourself and you bleed). The new cells are formed by cell division, or ***mitosis***. Every new cell formed by mitosis is identical in many ways to the original cell; that is, the new cell and the original cell contain the same genetic information. They both have a complete set of identical chromosomes.

Sometimes the cell that copies itself is a one-celled organism. In this case, mitosis has produced a new, complete organism identical to the original. This is ***reproduction***. Specifically, it is a kind of ***asexual reproduction*** (**binary fission**) because one original organism produces a new organism by dividing itself.

STEPS IN MITOSIS

1. The ***chromosomes*** in the nucleus replicate so there are two complete sets in the cell. The copy of each chromosome is connected to the chromosome that made it. This is a ***replicated pair.***
2. The chromosomes become thicker and shorter.
3. The ***nuclear membrane*** surrounding the nucleus breaks apart and disappears so the chromosomes are free to move.
4. ***Spindle fibers*** form from the middle of the cell to the ends of the cell.
5. The chromosomes line up in the middle of the cell.
6. The replicated pairs separate at the center and move to opposite ends of the cell. Each end of the cell now contains a complete set of chromosomes.
7. The spindle fibers disappear.
8. A new nuclear membrane forms around each set of chromosomes.
9. The ***cell membrane*** and ***cytoplasm*** divide between the two nucleuses, leaving two complete cells.

SEQUENCE

Below are the steps of mitosis. They are in the wrong order. The pictures at the bottom show the sequence of mitosis. Write the letter of the correct step under each picture. Some pictures may have more than one letter.

A. The replicated pairs separate.

B. Spindle fibers disappear and chromosomes are clumped at the poles.

C. The nuclear membrane begins to break apart and disappear.

D. The chromosomes line up at the equator.

E. Chromosomes replicate, leaving 2 complete sets of chromosomes.

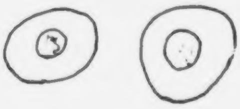
F. Spindle fibers form from the middle to the ends of the cell.

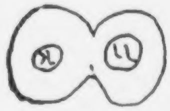
G. The cytoplasm divides, creating 2 completely separate cells.

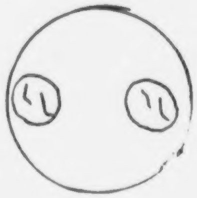
H. A nuclear membrane reforms around each bundle of chromosomes at the ends of the cell.

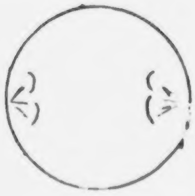
I. The separated chromosomes move toward the ends of the cell.

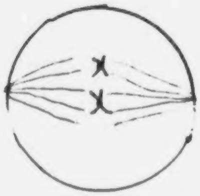
J. Chromosomes become shorter and thicker.

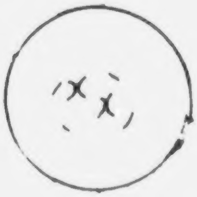


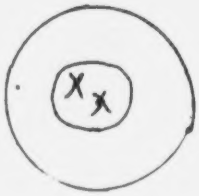












QUESTIONS ABOUT MITOSIS

Answer the questions below about mitosis.

1. a) What happened to the original cell after mitosis?

   b) Are the two new cells bigger or smaller than the original cell?

   c) Why?

2. a) Is mitosis a form of *reproduction* in many-celled organisms?

   b) Is mitosis a form of *reproduction* in single-celled organisms?

   c) In what ways could many-celled organisms use mitosis?

BACTERIA

BACTERIA

Bacteria are one-celled organisms. (***Bacterium*** is used for 1. ***Bacteria*** is for 2 or more.) They do not have organelles (such as mitochondria, nucleus). They do have many ***ribosomes*** (structures that make proteins). Bacteria have 1 chromosome and it is in a circle. Most have a ***cell wall***, a structure surrounding the cell membrane that gives support and structure to the cell.

GROWTH OF BACTERIA

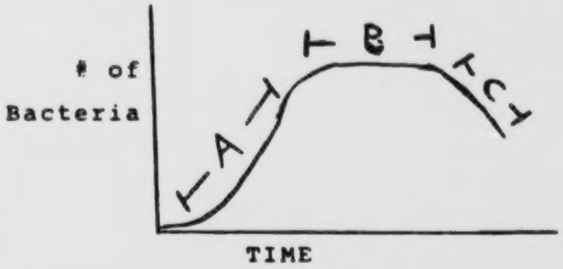
1. Generation time is the period of time it takes for a bacterium to divide and produce a new bacterium. For instance, if you have five bacteria and the generation time is 30 minutes, you would have 10 bacteria after 30 minutes and 20 bacteria after 1 hour. From the information below, determine the generation time of the bacteria.

   Number of bacteria at beginning: 1,000
   Number of bacteria after **1 HOUR**: 4,000

   How many bacteria will you have after two hours? ________________

   What is the generation time? ____________________

2. Below is a graph of the number of live bacteria in a culture versus time. Explain what is happening to make the graph appear as it does in areas A, B, and C.



Hints: What two processes are going on at all times in the bacteria population that affect the number of bacteria? Think about the rates of the two contrasting processes and how the difference between them would affect the number of live bacteria.

BACTERIAL KEY

Write a dichotomous key to distinguish these bacteria. Read the test results at the bottom to determine important characteristics of the bacteria. (Instructions for constructing dichotomous keys can be found in the CLASSIFICATION Unit, p. 38).

1. *Bacillus anthracis*
2. *Clostridium perfringens*
3. *Corynebacterium diptheriae*
4. *Mycobacterium tuberculosis*
5. *Streptococcus pyogenes*

Tests:

A. Is bacterium rod-shaped?
B. Is bacterium cocci-shaped (round)?
C. Does bacterium have spores?
D. Does bacterium grow in air?
E. Does bacterium grow on glucose?
F. Is bacterium motile (can it move)?

TEST RESULTS

	A	B	C	D	E	F
1	+	-	+	+	+	-
2	+	-	+	-	+	-
3	+	-	-	+	+	-
4	+	-	-	+	-	-
5	-	+	-	+	+	-

+ = positive result
- = negative result

Now read each line. For example: *Bacillus anthracis* is rod-shaped, has spores, grows in air, and grows on glucose. It is not round and it does not move.

YOUR JOB: CLEAN THE KITCHEN!

You are responsible for cleaning the kitchen counter after your parents cook dinner. You want to be sure that you kill the most bacteria possible. You aren't sure what product to use to clean the counter. You conduct an experiment, testing 5 different cleaners. You apply the cleaners to five different cultures of bacteria from the counter. You count the number of live bacteria at different times. The results are given in the table below. **Which cleaner should you use?**

Product	Number of live bacteria		
	1 min	5 min	30 min
Lysol	25	15	7
Soapy water	50	25	20
Pinesol	28	14	9
Osyl	20	7	5

*Many disinfectants kill a wide range of bacteria and cells. Not all disinfectants should be used to clean cuts on living things. Why?

HOW DID THEY GET THERE?

1. One way bacteria cause disease is by growing inside your body. List some ways bacteria could enter your body.

2. a) Why do surgeons wear masks?

   b) What part of the face do they cover?

   c) Who is being protected?

WHY....

1. Some bacteria have a very large, thick, sticky carbohydrate layer that surrounds the cell membrane. This is called a **capsule**. How could a capsule help the bacteria?

2. Salt was often added to meat before refrigerators were invented to keep food from spoiling. Bacteria usually cannot grow on very salty or very sweet foods. Why do you think this is?
Hint: Bacteria cannot grow on dry food, such as cereal, either.

3. Some bacteria, called **psychrophiles**, can live and grow only at very low temperatures.
a) Do you think these bacteria can grow in food in the refrigerator and freezer?

b) If so, why don't they cause disease in humans when we eat food with psychrophiles growing in it?

THE DIGESTIVE SYSTEM

THE DIGESTIVE SYSTEM

All living things need energy. Plants can make their own energy from sunlight, but animals must get their energy by eating. A group of organs called the ***digestive system*** in the animal's body changes the food into small molecules that its body can use as energy. This process is called ***digestion***.

Digestion requires both physical and chemical changes in the food we eat. These changes start in the ***mouth***, where the food is broken into small pieces and mixed with ***saliva***. Then the food goes down the ***esophagus*** to the ***stomach.*** In the stomach the food is mixed with other chemicals until it is mostly liquid. The food leaves the stomach and goes into the ***small intestine***. Most of the chemical digestion occurs in the small intestine. Then the digested food moves into the blood stream through the wall of the small intestine. Diffusion allows the ***nutrients*** (useable food molecules) to move from the small intestine into the blood stream. The unused food continues through the digestive system, into the ***large intestine***. This unused food is expelled from the body through the ***anus***.

STEPS IN DIGESTION

Location	Activity
1. mouth	**Chewing** grinds food into small pieces. Saliva is mixed with the food. Saliva contains an enzyme that begins to break down carbohydrates.
2. esophagus	**Swallowing** pushes the food into the esophagus. The muscles of the esophagus push the food into the stomach.
3. stomach	The stomach squeezes the food and mixes it with digestive chemicals. The most important chemicals are ***pepsin*** (an enzyme that digests proteins) and ***hydrochloric acid***. When the food leaves the stomach it is mostly liquid.
4. small intestine	Food goes from the stomach to the small intestine. Most digestion occurs here. The food is mixed with chemicals from other organs in the body. The small intestine secretes ***intestinal juice***, which digests carbohydrates and proteins. The ***liver*** provides ***bile***, which breaks fats into small molecules. The ***pancreas*** produces ***pancreatic juice***, which digests fats, carbohydrates, and proteins. (Bile and pancreatic juice enter the intestine through small tubes.) When the mixing and digestion is complete, the food is in a form that can be used by the cells of the body. The digested food molecules diffuse through the ***villi*** of the small intestine into the blood. The blood carries it to the cells.
5. large intestine (colon)	The parts of the food that cannot be digested (like fiber, for example) move into the large intestine. Water is removed from the feces (undigestible food) and returned to the body.
6. rectum	Feces are stored here until they can be eliminated from the body.
7. anus	Feces are pushed out of the body through the anus.

SEQUENCING AND IDENTIFICATION

1. Rewrite these body parts in the order food would pass through them in the digestive process. You may refer to the chart on the previous page if you have difficulty.

stomach ____________

mouth ____________

rectum ____________

esophagus ____________

small intestine ____________

anus ____________

large intestine ____________

Now go back and place a star next to the structures that produce some type of digestive enzyme or chemical.

2. Put a check mark by the structures that are accessory organs in digestion (that is, food does not pass through the structure, but the structure is actively involved in digestion).

___ gall bladder

___ lungs

___ liver

___ pancreas

___ trachea

___ teeth

___ heart

___ tongue

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

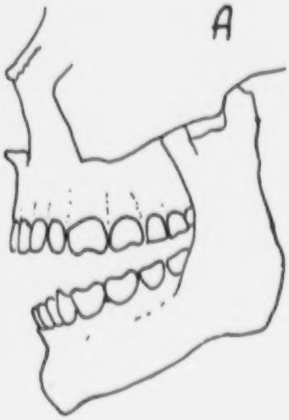
stomach

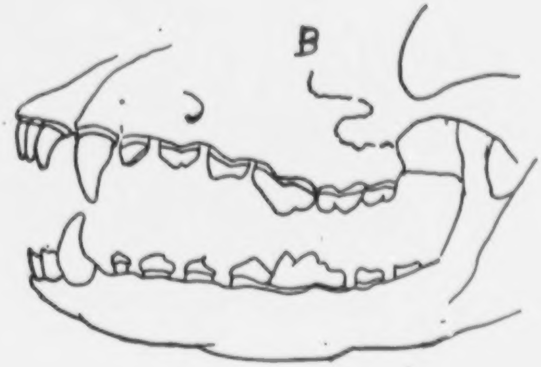
esophagus

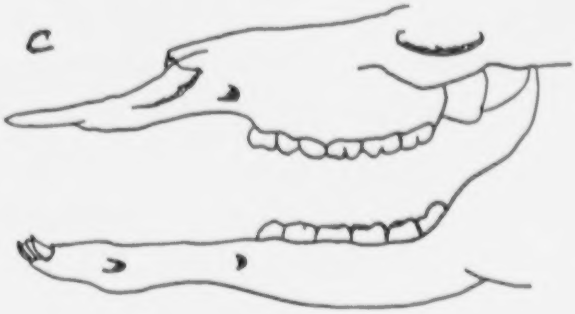
chewing

MATCHING TEETH WITH FOOD

There are many types of teeth. Some teeth are sharp and are good for tearing meat. Some teeth are thin and flat and are good for scraping. Other teeth are large and square with small bumps that are good for grinding tough food. Look at the pictures of teeth below. Match each picture with the type of food you think the animal with those teeth would eat.







Diets to choose from:

____ meat eater

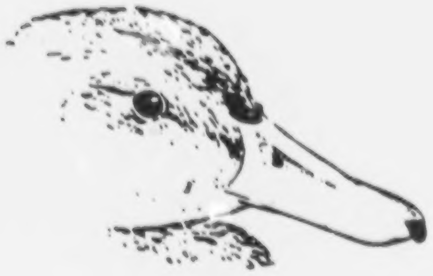
____ plant eater

____ meat and plant eater

Why did you choose each one?

MATCHING THE FOOD WITH THE BEAK

Look closely at these pictures of bird beaks (pointed mouths). Think about the shape of the beak and how it could be used to capture food. Try to match each beak with the correct method of eating listed at the bottom of the page.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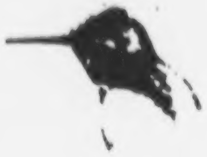
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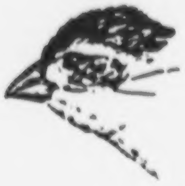
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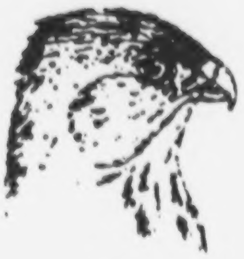

D

___ sucks nectar (juice) from flowers

___ filters small animals from the water

___ tears meat (eats small animals)

___ cracks open small seeds

Why did you choose each one?

MODIFYING THE DIGESTIVE SYSTEM

Below are some descriptions of animals with unusual feeding habits. How are their digestive systems different? Sometimes questions and hints are given to help you start thinking in the right direction. Think about what new organs the animal would need or what organs are not necessary. A description of the animal's actual digestive system is given in your partner's book.

1. A tapeworm is a parasite (an organism that steals nutrients from other oganisms). The tapeworm attaches itself to the intestinal wall of humans. The human intestine contains digested foods that are ready to be absorbed by the human body. How is the digestive system of the tapeworm different from the human digestive system?

   HINTS:

   a) Where does the tapeworm get its food?

   b) How does the food enter the tapeworm's body?

   c) What structures of the digestive system does the tapeworm need?

   d) What structures are unnecessary?

2. Snakes eat whole, live animals such as mice. They swallow mice without killing them first. The animal is often larger than the snake's mouth.

   a) What would the snake's teeth be used for?

   b) What kinds of things would be included in the undigested food?

3. A fly often feeds on pieces of solid food which it cannot take into its mouth. It has a sponge type mouth for sucking liquids into its body and for secreting liquids from its body. It does not have teeth.

   a) Can the fly take solid food into its body?

   b) How could the fly change solid food so that it can be eaten?

   c) How can the sucking mouth help the fly do this?

4. A finch (a kind of small bird) has no teeth. The finch feeds mostly on whole, hard seeds. Seeds are difficult to digest whole and need to be broken down. However, it is difficult to break down plant material with chemicals. How could the digestive system be modified to fit this way of feeding?

   a) What physical changes in the whole seeds would make them easier to digest?

   b) What structure is the finch missing that it needs?

   c) Can you invent a structure that would have the same function as the missing structure?

5. A deer eats mostly grass and other plants. Grass requires a lot of chewing to prepare it for digestion. A deer has many teeth specially designed for chewing plant material. However, a deer must usually watch out for predators when it is eating because the grass is in open fields where the deer is not protected. Therefore, the deer must eat quickly. Can you invent a digestive system for the deer?

6. A starfish feeds on clams. A clam's defense against being eaten is to "clam up" or shut its shells very tightly. However, it is difficult for the clam to remain tightly shut for a long time. Eventually a small opening may appear between the shells. How could the starfish take advantage of the small opening between the clam shells?

a) Does food have to be digested inside the body?

b) Does the digestive system have to stay inside an animal's body?

c) How could the starfish use the clam shell?

NUTRITION

NUTRITION

The food an animal eats must provide certain things to the animal. It must provide energy and certain chemicals that the body needs. It is very important for animals to eat the kind of foods that will provide the things the animal needs. The process of eating foods to help the body is called ***nutrition***.

FOOD ENERGY

A ***Calorie*** is a measure of the energy that a food can supply when it is eaten. Just as we can say that a banana has about 120 grams of weight, we can also say that it has 100 Calories of energy. A Calorie is defined in science as the amount of heat energy that can raise the temperature of 1000 grams of water by 1° Celsius.

All food contains Calories. Our bodies absorb this energy during digestion. If we need the energy for an activity, such as breathing, thinking, growing, talking, or moving, we use it quickly. If we do not need the energy, we store it as fat.

Name	Function	Examples
NUTRIENTS THAT ARE DIGESTED		
Carbohydrates (sugars & starches)	provide energy for body cells	fruits, vegetables, grains
Proteins	form hair, nails, ligaments, & muscles	meat, fish, beans, dairy products
Fats	provide energy for body cells; necessary for carrying certain vitamins	red meats, dairy products
NUTRIENTS THAT ARE ABSORBED BUT DO NOT NEED TO BE DIGESTED		
Vitamins	required for proper cell growth and many body functions	Vitamin C, B vitamins
Minerals	required for control and coordination of body functions	calcium, iron, potassium
ENERGY GAINED FROM DIGESTION		
Calories	are a measure of the energy that a food supplies when it is digested. Getting energy is the purpose of digestion.	All foods that can be digested have calories
SUBSTANCE (NOT A NUTRIENT) THAT AIDS IN DIGESTION		
Fiber	stimulates elimination of feces. This keeps undigested food moving quickly through the body.	raw fruits & vegetables, whole grains

Put the following foods into the proper food group. Some foods may go in more than one group.

broccoli
cinnamon
macaroni
pepperoni pizza
milk
shrimp
Cheerios
mangos
cabbage
chicken
chocolate cake
bacon
pineapple
blueberry muffins
mozzarella cheese
pork
rice
toast
bananas
oregano
chocolate chips

MEAT

DAIRY FOODS

BREADS/GRAINS

FRUITS & VEGETABLES

OTHER

What is the OTHER group for? The things in this group have little nutritional value and really do not belong to any of the four major food groups. Many of the foods we eat everyday are included in the OTHER group. These foods really do nothing but provide calories or flavoring.

Below are some recipes. Next to each ingredient, write which food group it would belong to. Also tell whether it is primarily a source of protein, fat, or carbohydrate. After each recipe, tell what food should be eaten with that food to make a complete meal.

FRIED RICE

1/4 cup vegetable oil
3 cups boiled rice
1 chopped onion
3/4 teaspoon salt
1/2 cup roast pork cut into squares
3 eggs
1 1/2 tablespoons soy sauce
1 cup chopped cabbage
1/2 cup pea pods

Heat the oil in a skillet. Add the rice, onion, salt, peas, and meat. Mix well. Make a hole in the center and add the eggs. Scramble the eggs and mix with the rice. Season with soy sauce.

*What could you eat with the fried rice to make it a complete meal? (What food group is missing?)

MEXICAN LAYERED DIP

10 corn tortillas, cut in medium pieces
1 cup cooked beef
1/2 cup sour cream
1/4 cup taco sauce
1 cup guacamole
1 cup Monterey Jack cheese
1/2 head chopped lettuce
2 chopped tomatoes
1/4 cup sliced jalapenos

On a plate, layer the beef, guacamole, sour cream, taco sauce, and cheese. Microwave on high for two minutes. Cover with the lettuce, tomatoes, and jalapenos. Serve with tortillas.

*Is this a complete meal?

READING NUTRITIONAL INFORMATION ON LABELS

White tuna in oil

Serving size:	2 ounces	% Recommended Daily Allowance (RDA)			
Calories:	120	Ribloflavin	2%	Vitamin B_{12}	20%
Protein	13 g	Niacin	30%	Vitamin B_6	15%
Carbohydrate	0 g	Iron	2%	Vitamin E	6%
Fat	7 g				

Cream of Chicken Soup

Serving size:	8 ounces	% Recommended Daily Allowance (RDA)	
Calories	110	Vitamin A	10%
Protein	3 g	Riboflavin	2%
Carbohydrate	9 g	Calcium	2%
Fat	7 g	Iron	2%

Frozen Green Beans

Serving size:	3 ounces	% Recommended Daily Allowance (RDA)			
Calories	25	Vitamin A	8%	Niacin	2%
Protein	1 g	Vitamin C	15%	Calcium	4%
Carbohydrate	6 g	Thiamine	4%	Iron	4%
Fat	0 g	Riboflavin	4%		

Cheerios (cereal)

Serving size:	1 ounce	% Recommended Daily Allowance (RDA)			
Calories	110	Vitamin A	25%	Calcium	4%
Protein	4 g	Vitamin C	25%	Iron	45%
Carbohydrate	20 g	Thiamine	25%	Vitamin D	10%
Fat	2 g	Riboflavin	25%	Vitamin B_6	25%
		Niacin	25%	Vitamin B_{12}	25%

1. Which of the foods above contains the most protein per ounce?
   A. Cheerios
   B. White tuna in oil
   C. Cream of chicken soup

2. Arrange the four foods in order of fat content per ounce. Put the food with the highest fat content first.
   A. Cream of chicken soup, White tuna in oil, Cheerios, Frozen green beans
   B. White tuna in oil, Cream of chicken soup, Cheerios, Frozen green beans
   C. White tuna in oil, Cheerios, Cream of chicken soup, Frozen green beans

3. Which of the following foods would have the highest percentage RDA of Riboflavin in a 4 ounce serving?
   A. Frozen green beans
   B. White tuna in oil
   C. Cream of chicken soup

4. Which of the following foods has the most carbohydrate per serving?
   A. Frozen green beans
   B. White tuna in oil
   C. Cream of chicken soup

5. Why do the serving sizes differ?

6. Why do you think the vitamin and mineral information is given in percents?

EVALUATING A MEAL

For good nutrition, a meal should include something from all four food groups. It is also important to have a good mix of protein, carbohydrates, and fat. The recommended mix is 15% protein, 55% carbohydrates, and 30% fat. Read the three menus below. Decide which one is the best nutritionally. Answer the questions which follow the menus.

	Calories	Protein	Fat	Carbohydrate
A. Hamburger				
—meat	245	21 g	17 g	0 g
—bun	140	4 g	2 g	26 g
French fries	155	2 g	7 g	20 g
Milk	160	9 g	9 g	12 g
B. Baked Ham	245	18 g	21 g	0 g
Mashed potatoes	125	4 g	1 g	25 g
with butter	35	0 g	4 g	0 g
Green beans	30	2 g	7 g	10 g
Apple pie	350	3 g	15 g	51 g
with ice cream	95	2 g	5 g	10 g
C. Bologna sandwich				
—meat	135	11 g	10 g	0 g
—bread	140	4 g	2 g	26 g
Potato chips	115	1 g	8 g	10 g
Pickle	10	1 g	0 g	1 g
Coca-cola	145	0 g	0 g	37 g

1. Which meal is the most nutritious?

2. Which meal provides the most calories?

3. Does meal A need anything to make it nutritionally complete? If it does, what would you add?

THE CIRCULATORY SYSTEM

CIRCULATION

Many different substances need to be moved from place to place inside your body. Nutrients must be delivered to body cells so that the cells can grow and reproduce. Wastes created by the cells must be removed before they can damage the body. Chemicals produced in one part of the body (such as hormones) must be transported to the parts of the body that can use them. Finally, the body's defenses for fighting infection must be able to go to the part of the body that needs help.

Your blood does all of these things. Blood delivers nutrients to the cells, takes wastes away from the cells, transports chemicals, and fights infection. The ***circulatory system*** (the heart and the blood pathways) is the transportation system of the body.

HOW THE HEART CIRCULATES BLOOD THROUGH THE BODY

Look at the pictures of the heart in your book.

1. The ***left atrium*** (upper chamber) of the heart receives blood from the lungs. This blood carries lots of oxygen.

2. The left atrium squeezes together. This pumps the blood into the ***left ventricle*** (lower chamber).

3. The ***valve*** between the two chambers closes.

4. The left ventricle squeezes together. Because the valve between the two chambers has closed, the blood cannot go back into the left atrium. Instead, it goes into the ***aorta*** (the body's main artery).

5. Blood vessels that carry blood away from the heart are called ***arteries***. The aorta branches into smaller arteries, which then branch into even smaller ones. The very smallest branches are called ***capillaries***. The blood finally reaches the capillaries.

6. The blood in the capillaries exchanges products with nearby cells. Nutrients, oxygen, and chemicals from the blood diffuse into the cells; waste substances and cell products (such as hormones) diffuse from the cells into the blood.

7. The blood begins its return trip to the heart. Blood vessels that carry blood toward the heart are called ***veins***. Blood flows into the smallest veins, which begin to join each other to create larger and larger veins.

8. The two largest veins return the blood to the ***right atrium*** of the heart.

9. The right atrium squeezes together. This pumps the blood into the ***right ventricle.***

10. The valve between the two chambers closes.

11. The right ventricle squeezes together. Because the valve between the two chambers has closed, the blood cannot go back into the right atrium. Instead, it goes into the ***pulmonary artery*** (a large artery that leads to the lungs).

12. In the lungs, the blood exchanges the carbon dioxide it got from the cells (a waste substance) for the fresh oxygen breathed in by the lungs. (The carbon dioxide is breathed out by the lungs).

13. The blood, which now carries a lot of oxygen, goes into the ***pulmonary vein*** (a vein that leads from the lungs to the heart). Blood from the pulmonary vein flows into the left atrium of the heart, and the process starts over.

SEQUENCE AND IDENTIFY

Rewrite these structures in the order blood would go through them. Start with the right atrium.

____ right atrium
____ left atrium
____ lungs
____ right ventricle
____ pulmonary artery
____ arteries to the body
____ pulmonary vein
____ veins from the body
____ left ventricle
____ aorta
____ capillaries in the body

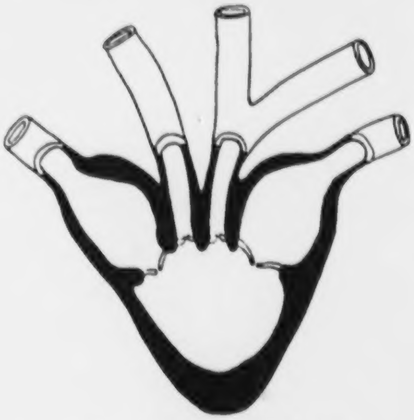
1. right atrium
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____
8. ____
9. ____
10. ____
11. ____

Now go back over your list and place a star (*) next to the structures that contain blood with a high oxygen content.

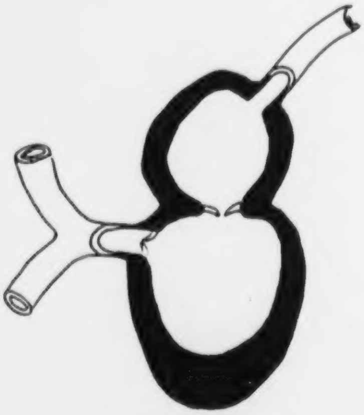
DIFFERENT HEART STRUCTURES

Only mammals and birds have a heart with four chambers (2 atriums and 2 ventricles). Lower vertebrates may have 3 or 2 chambers. Frogs and snakes have 3-chambered hearts — left and right atriums and 1 ventricle. Fish have 2-chambered hearts — 1 atrium and 1 ventricle.

Trace the flow of blood through the 3-chambered heart and the 2-chambered heart below. Indicate where the blood has a high oxygen content and where it has a low oxygen content.



3-chambered heart



2-chambered heart

1. What is the advantage in a 4-chambered heart? How is it more efficient?

2. How is a 3-chambered heart more efficient than a 2-chambered heart? In what way is it less efficient?

3. What do you think happens in the ventricle of the 3-chambered heart?

DIFFERENT CIRCULATORY SYSTEMS

The circulatory system of humans is called a **closed system**. Some other animals have an **open circulatory system**.

1. Can you guess what the difference in closed and open systems is?

2. What feature of our circulatory system would make it "closed"?

3. Is there an advantage in a closed system?

BLOOD PRESSURE

Blood pressure is a measure of the force with which blood moves through blood vessels. If blood pressure is too high, blood vessels and body organs can be damaged. If the blood pressure is too low, blood may not reach all the parts of the body. The force that the heart exerts while pumping the blood is one factor that affects blood pressure. Other factors can also affect blood pressure. Answer the questions below about blood pressure.

1. How would the size of the blood vessel affect blood pressure? (What would happen if the blood vessels were smaller in diameter? What would happen if they were larger in diameter?

2. If the blood is made thinner, would blood pressure be lower or higher?

3. Sometimes blood pressure is so low, blood cannot make it back up the veins in the legs. What would happen to the person?

COMPONENTS OF BLOOD

Name	Form	Function
plasma	liquid	Carries the solid blood cells through the body; also contains dissolved nutrients
red blood cells	solid	Carries oxygen through the body and takes away carbon dioxide. Red blood cells contain ***hemoglobin***, a substance that oxygen is attracted to.
white blood cells	solid	Fights infection by attacking bacteria and and other substances that shouldn't be in the body (foreign substances)
platelets	solid cell fragments	If vessels have been cut, platelets link together to form a net across the opening. The net catches blood cells and stops the bleeding. This is called ***clotting***.

FUNCTIONS OF BLOOD COMPONENTS

Answer the questions below about the blood and blood components.

1. Small cuts in the skin usually stop bleeding after a short time. The blood clots. What blood component is responsible? ____________________

2. As the blood passes through the lungs, oxygen combines chemically with something in the blood. What blood component is involved?

   ____

   What chemical in that component does oxygen combine with?

   ____

3. As the blood passes by the small intestine, digested particles diffuse into the blood. In what blood component are the nutrients dissolved?

   ____

4. When bacteria infect the body, cells in the blood fight the infection by killing the bacteria. What blood component is responsible?

   ____

5. A hemophiliac is a person who cannot stop bleeding when they are cut. What process in the blood is not working properly in a hemophiliac?

   ____

6. When organs are transplanted into sick people to replace an organ that is no longer working, drugs that suppress the body's reaction to foreign substances are given. Why? ________________________________
   What blood component makes these drugs necessary? ______________

GUESSING THE CONCEPT

For each category shown below, all the things in the Yes column share a certain characteristic. The things in the No column do not have this characteristic. Compare the two columns and tell what characteristic the things in the Yes column share. (Hint: When you have a guess, check the items in the No column. If any of these items have the characteristic you guessed, your guess must be wrong.)

1.

YES	NO
left atrium	pulmonary artery
left ventricle	right atrium
aorta	right ventricle
pulmonary vein	veins from the feet

2.

YES	NO
red blood cells	plasma
white blood cells	lymph
platelets	water

3.

YES	NO
nutrients	bile
oxygen	hair
carbon dioxide	hydrochloric acid
platelets	lymph
waste products	nitrogen
hormones	

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

oxygenated blood

artery

hemoglobin

THE RESPIRATORY SYSTEM

RESPIRATION

Cells in the body use oxygen in a complex chemical reaction. This reaction lets the body get energy from digested food. This chemical process is called ***respiration***. The human body does not produce oxygen or store it, so the oxygen must constantly be brought into the body from outside. When oxygen is used in this chemical reaction, carbon dioxide and water are created. The body cannot use the carbon dioxide. The body must remove it. The process of ***breathing*** is the way that the body brings in oxygen and takes carbon dioxide out. The ***respiratory system*** is the structures that are involved in breathing

THE PATH OF AIR IN THE RESPIRATORY SYSTEM

1. Air is ***inhaled*** (breathed into the body) through the nose. The nose warms, cleans, and moistens the air.
2. The air moves through the ***pharynx***, ***larynx*** (voice box), and the ***trachea*** (the windpipe). The trachea divides into two tubes called the ***bronchial tubes***.
3. The air moves through the bronchial tubes to the ***lungs***. Inside the lungs, the bronchial tubes divide into smaller and smaller branches called ***bronchioles.***
4. The air moves through the bronchioles. At the ends of the smallest bronchioles are air sacs called ***alveoli***. Each alveoli is surrounded by capillaries.
5. Air moves into the alveoli. Oxygen from the air diffuses through the capillaries into the blood. Oxygen combines with ***hemoglobin*** in the red blood cells to form ***oxyhemoglobin***.
6. Carbon dioxide from the blood diffuses through the capillaries into the alveoli.
7. The carbon dioxide is ***exhaled*** (breathed out of the body) by the lungs (through the series of tubes described above) through the nose.
8. The blood carries the oxygen to body cells, where it diffuses into the cells. The carbon dioxide in the body cells diffuses into the blood.

SEQUENCE AND IDENTIFY

Rewrite the following structures in the order in which air (oxygen) passes through them when entering the body.

alveoli

nose

trachea

bronchial tubes

pharynx

bronchioles

blood

larynx

Now go back through your list of structures. Place a star (*) next to the structures which are part of the lungs.

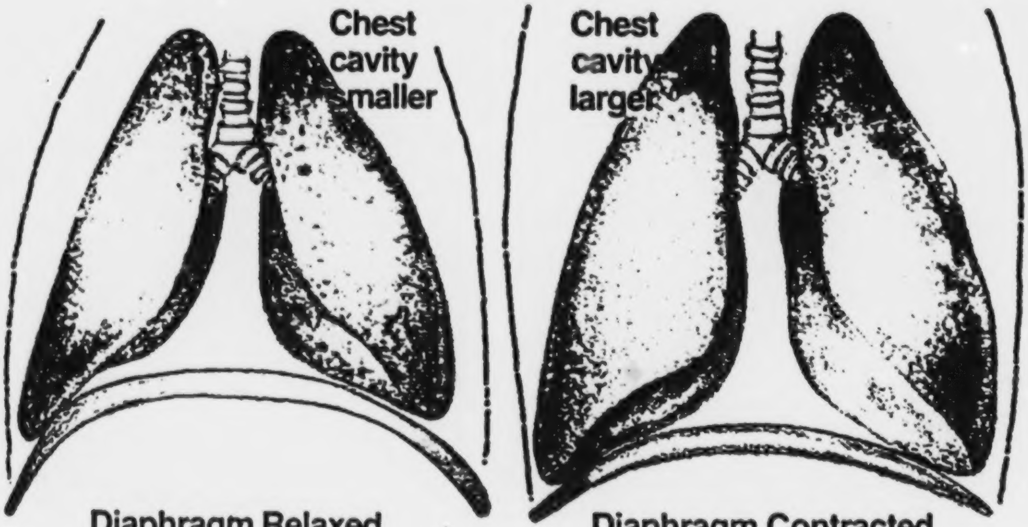
STEPS IN BREATHING

1. The muscles in the rib cage contract to expand the rib cage. The ***diaphragm***, a muscle underneath the lungs, contracts. These two things together increase the space around the lungs.

2. The ***lungs*** are elastic (they can stretch and get smaller). When the space around the lungs increases, the lungs expand to fill the extra space. Air rushes into the lungs because of the extra room inside. This is ***inhaling***.

3. The diaphragm and the muscles in the rib cage relax. This reduces the space for the lungs.

4. The lungs return to their normal size. The extra air in the lungs is pushed out. This is ***exhaling***.



Diaphragm Relaxed **Diaphragm Contracted**

QUESTIONS ON BREATHING

Answer the following questions.

1. Which has the *highest* concentration of oxygen?
   A. inhaled air
   B. exhaled air

2. When the diaphragm relaxes, air is
   A. inhaled
   B. exhaled

3. What causes air to be inhaled into the lungs?
   A. the diaphragm contracts
   B. the diaphragm relaxes
   C. the lungs contract

4. If the diaphragm were suddenly disabled, would your last breath be inhaling or exhaling? Why?

5. After you exhale, can you force more air out of the lungs? Why? What does this tell you about exhaling?

6. Artificial respiration is a life-saving skill. In artificial respiration, you place your mouth over the mouth of someone who has stopped breathing and exhale into their mouth, forcing the air into their lungs. Since the air you are forcing into their lungs is the air you were exhaling, how does it help the person? Does it contain oxygen?

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diaphragm

breathing

lungs

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

COMMON FEATURE

1. pharynx trachea
   esophagus bronchiole

2. rib cage bronchial tubes
   diaphragm lungs

3. heart gills
   lungs skin

4. diaphragm relaxes you can talk
   rib muscles relax oxygen binds to hemoglobin

5. clean extract oxygen
   moisten warm

HOW AQUATIC ANIMALS BREATHE

1. Below is a picture of a **gill**, the respiratory organ found in most kinds of fish. The gills are on both sides of the fish, near the head. They are exposed to the water, with a small flap of scales covering them. Water flows over the gill. Oxygen diffuses from the water into the circulatory system.

   a) Do fish breathe?

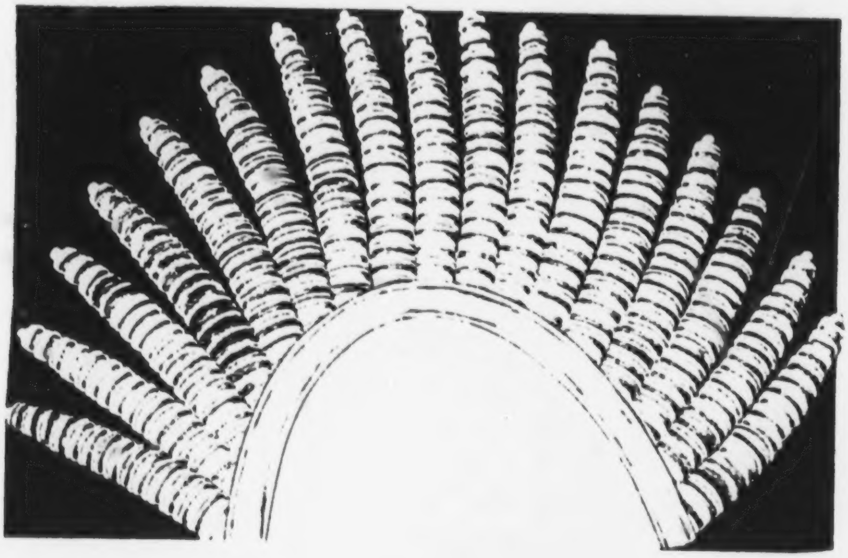
   b) Where do they get oxygen?

   c) Why can't animals with lungs get oxygen from the water? (Hint: Think about how air gets in and out of the lungs. What would happen if water were coming in instead of air?)

2. Circle the area of the gill where you think the most oxygen is picked up. What part of the lungs is this like?

3. Many fish do not actively pump water through their gills like humans pull air into the lungs. How could the fish move water over the gills?

   If these fish are unable to move in the water, they will die. What do they die of?

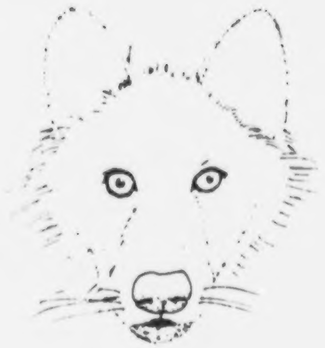


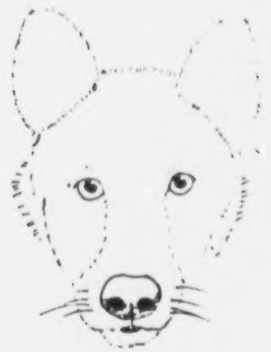
THE ROLE OF THE NOSE

The nose has three important functions: 1) to warm the air that enters the respiratory system, 2) to moisten the air that enters the respiratory system, and 3) to clean the air that enters the respiratory system. Many capillaries in the nose help the nostrils warm the air. The inside of the nose is lined with mucous and tiny hairs.

1. How do the mucous and hairs help the nose perform the other two functions?

2. These are two different species of wolves. One wolf lives in Florida, a warm, wet place. The other wolf lives in Alaska, a cold, dry place. Look at the noses of the wolves. Can you tell from the noses which wolf lives in Alaska and which lives in Florida? Explain your answer. (Hint: Think about the functions of the nose.)





ACHOO!!

Jim has a cold. He keeps sneezing. His nose is stuffed up. He coughs almost as much as he sneezes.

Maria wants to play a joke on her teacher. She sprinkles pepper all over a flower and then has her teacher, Mr. Kenny, smell the flower. The teacher begins to sneeze uncontrollably.

The respiratory system is responsible for both of the situations above.

1. Why do people sneeze?

2. What is making Jim's nose stuffy?
   Why do people cough?

3. Why did Mr. Kenny sneeze when he smelled the pepper?

4. How are these two situations (Jim and Mr. Kenny) similar?

5. What function of the nose is involved?

6. Sometimes when your nose is stuffed up, you breathe through your mouth. This usually makes your throat dry and sore. Why? What does the nose do that the mouth cannot do?

DIAGNOSING MEDICAL PROBLEMS

1. When gasoline or other fuels are burned, carbon monoxide is formed. Carbon monoxide and hemoglobin are attracted to each other very much. Hemoglobin is more attracted to carbon monoxide than it is to oxygen.

   a) What would happen if you worked on a car with the garage door closed and the engine running?

   b) What would happen to your cells if you breathed carbon monoxide? Why?

2. Smoking tobacco is bad for your lungs. Chemicals in tobacco make your lungs less elastic. How would this affect breathing? (Think about how your lungs change during breathing.)

   Smoking also produces chemicals which destroy the walls of the alveoli. How would this affect gas exchange in the lungs?

3. Asthma is a disease that affects the respiratory system. When a person has an asthma attack, it becomes very difficult to breathe. Often, the **throat** makes a "wheezing" or "whistling" sound during breathing. What is causing the difficulty in breathing? What is causing the sound?

   (Hint: Put your mouth in the shape to say "Ah". Blow air out through your mouth. Do you hear a sound? Now whistle. How did you change the shape of your mouth to make the whistle sound? What structure used in breathing is producing the wheezing during an asthma attack?)

MODIFYING THE RESPIRATORY SYSTEM

1. A whale is a very large mammal that lives completely in the water. A whale has lungs and does not have gills. How is the whale's respiratory system different from the human respiratory system?

   a) Can the whale get oxygen from the water?

   b) How could the whale get air?

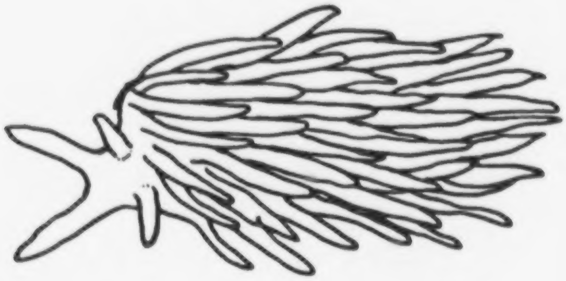
   c) Do you think the whale breathes as often as other mammals?

   d) If the whale doesn't breathe as often, how can it supply its cells with enough oxygen?

2. This animal is a nudibranch. It is a very small animal, about the size of a small insect. It lives in the ocean. The nudibranch does not have a respiratory system. Can you guess how it gets oxygen into its cells and carbon dioxide out?

   a) What process allows cells to exchange substances?

   b) How would the shape of the nudibranch's body help make this process more efficient?



THE EXCRETORY SYSTEM

EXCRETION

Substances that the cells of the body cannot use are called ***wastes.*** Many of the wastes found in the body are produced as the body goes about its normal functions. For example, ***ammonia*** is a waste product produced as the body digests proteins. Ammonia is poisonous to cells. Your body must remove the ammonia from the cells before it begins to kill the body cells. (Ammonia is changed into ***uric acid***, a non-poisonous chemical, in the body, so that it can be stored and removed from the body periodically.)

Not all wastes are poisonous like ammonia. Some wastes are merely excess amounts of things that your body normally uses. For example, if your body has more water than it needs, the excess water is called waste. If these wastes were allowed to accummulate in the body, there would eventually be so much waste that there would not be any room for functioning cells.

The ***excretory system*** removes wastes from the body before they can harm functioning cells. The ***kidneys***, the ***lungs*** and the ***skin*** are all excretory organs. Each removes different wastes from the body.

WASTES THAT ARE NORMALLY EXCRETED FROM THE BODY

Type of Waste	How the waste is produced	How the waste is removed from the body
ammonia	result of protein digestion	filtered from blood in kidneys; leaves as urine through the urinary tract
carbon dioxide	produced when cells use digested food for energy	removed from blood in lungs; leaves lungs in exhaled air (see the unit on respiration)
water	produced from normal cell activity and digestion	1) filtered from blood in kidneys; leaves as urine through the urinary tract 2) leaves the body through the skin as sweat
salt	brought into the body through eating; produced through normal cell functioning	1) filtered from the blood in kidneys; leaves as urine through the urinary tract 2) leaves the body through the skin as sweat
some vitamins	brought into the body through eating	filtered from the blood in kidneys; leaves as urine through the urinary tract

HOW THE KIDNEYS FUNCTION

1. As blood travels through the body, it acquires wastes from the body cells.
2. All blood at some time passes through the ***kidneys*** to be cleansed.
3. As the blood passes through, the kidneys filter the wastes and excess water.
4. The wastes are collected in the kidney in the form of ***urine*** (excess water and wastes).
5. Urine leaves the kidneys through small tubes called the ***ureters.***
6. The ureters take the urine to the ***urinary bladder***, where urine is stored until it can be expelled from the body.
7. When the bladder is full, the urine is expelled from the body through a tube called the ***urethra***.

HOW THE LUNGS EXCRETE* CARBON DIOXIDE

(These steps are also found under RESPIRATION)

1. Carbon dioxide in body cells diffuses into the blood.
2. The blood is carried to the capillaries surrounding the alveoli of the lungs. The carbon dioxide diffuses into the alveoli.
3. The carbon dioxide is breathed out of the body through the lungs.

*The lungs are an excretory organ as well as part of the respiratory system.

IDENTIFICATION

Put a check mark next to all the organs involved in some type of excretion.

____ skin

____ liver

____ kidneys

____ lungs

____ urinary bladder

____ pancreas

____ gall bladder

____ large intestine

Put a **check** next to the substances that may be excreted from the body as waste. Put an **S** next to those excreted through the **skin**. Put a **U** next to those excreted in **urine**. Put a **B** next to those excreted in your **breath**. Some substances may be excreted in more than one place, and therefore can receive more than one letter.

____ salt

____ protein

____ water

____ ammonia

____ sugar

____ oxygen

____ carbon dioxide

Rewrite these structures in the order ammonia passes through them.

kidney ____________

blood ____________

urethra ____________

body cells ____________

ureter ____________

urinary bladder ____________

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

exhaling

carbon dioxide

lungs

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

1. skin lungs
   pancreas kidneys

2. salt vitamins
   water sugar

3. respiratory system endocrine system
   digestive system circulatory system

4. renal artery ureter
   bladder urethra

EXCRETION IN DESERT MAMMALS

Think about the three ways wastes are excreted: in urine, in sweat, and in water droplets in exhaled air. All of these methods use water. This presents a problem for mammals that live in the desert. These animals need to keep as much water as possible, but they also need to get rid of their body wastes. How could the excretory system be modified to accomodate the extremely dry environment of the desert?

1. What type of food should a desert animal avoid eating to reduce the amount of urine produced? What kinds of food should the animal eat instead?

2. The urine of most mammals is about 10% dissolved wastes (minerals, salt).
   a) How do you think the urine of desert mammals is different from most mammals?

   b) How is this an advantage for desert mammals?

3. The kangaroo rat is a small rodent that lives in the desert. It spends most of the day buried in a hole underground. The opening to the hole is covered with leaves and rocks.
   a) How could this situation help the kangaroo rat save water lost in exhaling?
   b) Does it help the rat save water in any other ways?

EXCRETION IN AQUATIC ANIMALS

Animals that live in the water often have much simpler excretory systems than land animals. In fact, many do not need a "system" at all. Answer the questions below about excretion in aquatic animals.

1. Small animals that live in the water often have no excretory system.
   a) How do they get rid of body wastes? (Hint: Think about how wastes are filtered from human blood in the kidney)

   b) What keeps the wastes the animal has just released from going back into the animal's body?

   c) Is there an excretory process in humans that is similar to the excretion process in these small aquatic animals?

2. Fish have kidneys that function much like a mammal's kidney. However, they mostly function to remove non-poisonous wastes, such as salt and excess water. Ammonia is excreted across the gills (the respiratory structure) directly into the water. Ammonia is not changed to uric acid, as it is in land animals.
   a) Why isn't it necessary for the fish to change ammonia to uric acid?

   b) Why isn't ammonia excreted with the other wastes?

URINE IN MEDICAL ANALYSIS

When doctors are checking on a patient's health or trying to determine what is wrong with someone, they often ask for a sample of the patient's urine. The urine is analyzed to see what substances are in it and how much of each substance there is.

a) What is normally found in urine?

b) What kinds of things do you think the doctor is looking for?

c) How would information about the contents of the urine help the doctor?

d) Can you predict some things that might be in the urine that shouldn't be?

THE SKELETAL AND MUSCULAR SYSTEMS

SKELETAL SYSTEM

The network of ***bones*** in the body is called the ***skeleton***. The bones of the skeleton have several important functions. First, bones support the weight of the body. Second, they protect the organs of the body by providing a hard covering for them (for example, the bones in your head protect your brain). Third, the inner part of the bone, the marrow, manufactures red blood cells. Fourth, the gones store calcium for the body to use. And finally, many of the body's muscles are attached to bones, making it possible for you to move.

Bone has many different parts. The outside of a bone is covered with a thin covering which contains many nerves and small blood vessels to nourish the bone. The ends of bones are sometimes covered with ***cartilage***, a clear, flexible material. The ends of bones are composed of ***spongy bone***. This part of bone is strong, but it contains many empty spaces. Most of the bone is made of ***solid bone***. This is very compact and strong. This is where calcium is stored. The middle of the bone is called the ***bone marrow***. It is very soft. The bone marrow produces blood cells and platelets.

The point where bones meet is called a ***joint.*** There are several types of joints. Each types allows a different type of movement between the bones. For instance, a ***suture*** is a joint between bones in the skull. Sutures do not allow any movement between the skull bones. A ***hinge*** joint connects the bones in the upper arm to the lower arm at the elbow. A hinge allows the bones to move in only two directions, like the hinge on a door.

Ligaments are long fibers which hold bones together. ***Tendons*** are fibers which attach muscles to bones.

MUSCULAR SYSTEM

Muscles are the tissues of the body that cause movement. When you walk, it is the muscles that move and pull the rest of the body with them. When you digest food, it is muscles that move the food through your digestive system. When your heart beats, it is muscles that pump the blood. Muscles move by ***contracting***. Contraction means getting smaller. The parts of the muscle pull closer together, making the muscle smaller. If the muscle is attached to a bone, the bone moves when the muscle gets shorter.

There are three kinds of muscle in the body: skeletal, smooth, and cardiac. ***Skeletal muscles*** (also called voluntary, striped, or striated muscles) are the muscles that you can control. These muscles are attached to bones. Skeletal muscles are grouped into pairs that control opposite movements. For example, one muscle bends your arm and its partner muscle straightens your arm.

Smooth muscles (also called plain, involuntary, and visceral muscle) are muscles that you cannot control. Your stomach muscles automatically squeeze the food that you eat. You do not tell the stomach muscles to move.

The third type of muscle, ***cardiac muscle***, is only found in the heart. Cardiac muscle is striped like skeletal muscle. However, movement of cardiac muscle is involuntary (you cannot control the way your heart beats).

MATCHING

Draw lines connecting the structures listed on the left with the descriptions or functions listed on the right.

ligament

cartilage

solid bone

bone marrow

outer bone covering

tendons

muscles

soft cushion frequently found on the ends of bones

contains many small blood vessels and nerves

produces blood cells and platelets

Stores calcium

Holds bones together

Contracts and moves bones

Connects muscles to bones

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

1. running swallowing
   blinking thinking

2. spongy bone marrow
   cartilage solid bone

3. support muscle attachment
   protection calcium production

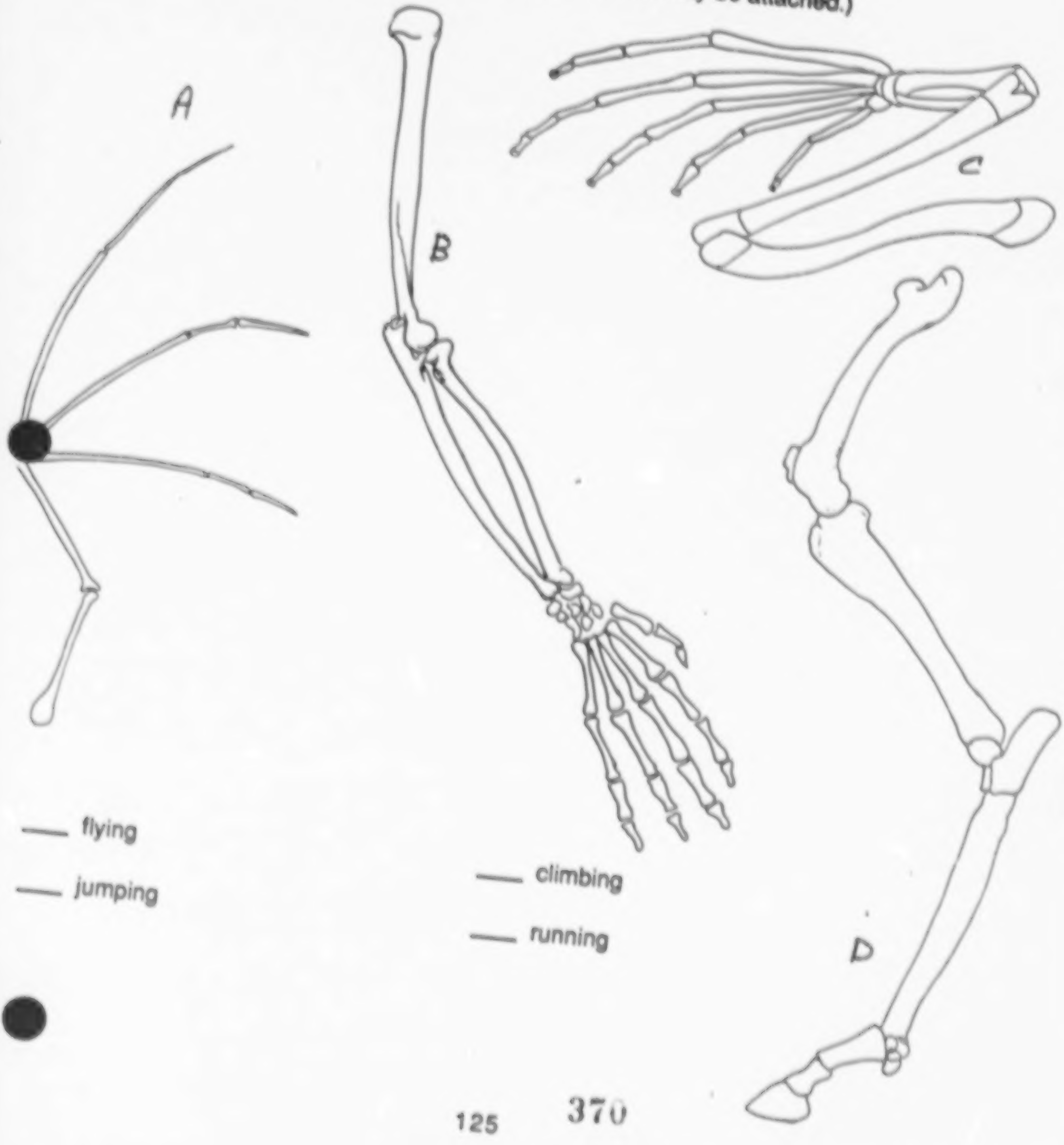
4. skull pelvis
   rib cage leg bone

5. elbow hip
   knee rib

6. tendons smooth muscle
   ligaments skeletal muscle

MATCHING BONES WITH MOVEMENT

Compare the bone structures of the limbs (arms, legs, wings) drawn below to the activities listed at the bottom of the page. Match each limb with the activity you think it is best suited for. (Think about the shape of the limb and the funcitons of the bones and how the muscles may be attached.)



__ flying

__ jumping

__ climbing

__ running

MATCHING

Match the muscle type on the left with the proper function in the right column.

skeletal	Muscle of the heart. It is under involuntary control.
cardiac	Moves limbs, etc. It is under voluntary control.
smooth	Controls body organs and vessels. It is under involuntary control.

Match the joint types on the left with the proper description in the column on the right.

ball & socket	movement back and forth **or** up & down
hinge	complete circular or rotary movement
suture	no movement

JOINTS

Test the joints in your body and decide which type they are.

Moveable joint types:
hinge
ball and socket
biaxial (like two hinge joints put together)

elbow ______________

knee ______________

shoulder ______________

hip (thigh to body joint) ______________

wrist ______________

ankle ______________

finger to hand ______________

finger knuckles ______________

thumb to hand ______________

jaw ______________

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

muscle contraction

movement

cardiac muscle

marrow

MUSCLES

1. There are many types of muscles. Not all of them are long, like arm and leg muscles are. Some are round. They are called ***sphincter*** muscles. The sphincter muscles open and close tubes or openings. Name the places in your body you might find sphincter muscles.

2. Find the muscles in your body that perform the following movements. Can you feel the muscles work? Can you tell when they are contracting and when they are relaxing?

   chewing
   pointing your foot
   bringing your hand toward your shoulder
   nodding your head
   smiling
   raising your eyebrows

3. Can muscles move if they are not attached to a bone? What types of muscles are not attached to bone?

MEDICAL QUESTIONS

1. You jump out of a tree. When you land, you hear something snap and you feel pain in the lower part of your leg. You have broken one of the bones in your lower leg. The doctor puts a cast (hard covering) on your leg.
   a) Why does the doctor put a cast on your leg?

   b) What is happening when the bone "heals"?

   c) The cast will keep some joints from moving. Which ones? Why? (Hint: More than one joint will be immobilized).

2. Someone pulls your arm very hard. You hear a popping sound and feel extreme pain in your shoulder. You can't move your upper arm; it hangs limply from your shoulder. None of your bones are broken.

   a) What part of the skeletal system do you think has been injured?

   b) What do you think happened?

   c) How would you fix the problem?

3. A person whose legs are paralyzed cannot move the muscles of the leg.
   a) What do you think happens to the muscles if they are not exercised?

   b) What could be done to stop this process?

4. When a person is cold, he will often shiver (the body shakes slightly all over).
   a) What must be happening to make the body move?

   b) How does this help heat the body?

5. Tetanus is a disease caused by the bacteria *Clostridium tetani*. This bacteria produces a chemical like the one your nerves produced to tell a muscle to contract.
   What effect would this have on a person infected with the bacteria?

VARIATIONS

1. When birds fly, they must be able to lift all their weight off the ground and keep it suspended in the air. Birds have very large muscles in their chest, leading to their wings, which enable them to produce enough force to fly.
   a) How could the skeletal system be modified to make flying easier?

   b) How must the bones in the chest change because of the large chest muscles? (Think about the functions of the skeleton.)

2. Insects have a complex ***exoskeleton*** with many joints. It is not made of living cells. It is made of chemicals that have hardened.
   a) Can an exoskeleton grow like our bones grow?

   b) What must happen to the exoskeleton when the rest of the insect grows?

   c) What are some disadvantages to this type of growth?

3. Compare an exoskeleton (like insects have) to an endoskeleton (like we have). Decide which one is better for each of the categories listed.

	Exoskeleton	Endoskeleton
Protection		
Support		
Muscle Attachment		
Growth of Organism		
Light (not heavy) Skeleton		
Movement (Flexibility)		

THE NERVOUS SYSTEM

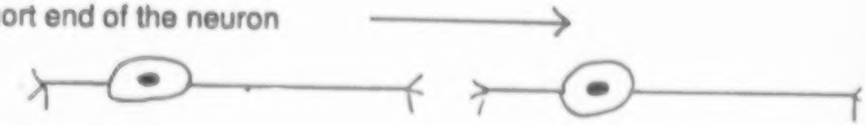
THE NERVOUS SYSTEM

The ***nervous system*** is a control system for the body. It is the message system that directs and coordinates all of the body's activities. The nervous system carries messages between the environment that we live in, the brain, and all the parts of the body.

The ***brain***, the ***spinal cord***, and the network of ***nerves*** that run throughout the body make up the nervous system. The brain and the spinal cord are called the ***central nervous system*** (in the center of the body); the network of nerves is called the ***peripheral nervous system*** (along the edge or outer part of the body).

Messages from one part of the nervous system to another travel along nerves. Nerves are made up of long lines of nerve cells, or ***neurons***. When a message begins to move along a nerve, it starts at the first neuron and moves

1. from the fibers at the short end of the neuron
2. through the cell body
3. along the fibers at the long end, and
4. jumps across the synapse (space between neurons) to the fibers at the short end of the next neuron.



It is important to see that the two ends of the neuron are different. Impulses that travel through neurons always start at the short end and go to the long end. This means that *impulses may travel in only one direction*. So, a set of neurons may carry impulses from either the body to the brain, or from the brain to the body, but not both.

For this reason, nerves work in pairs. One set of neurons is lined up to carry impulses from your sense organs to your brain. These are called ***sensory neurons***, because they collect information sensed by the body. A second set of neurons is lined up to carry impulses from your brain to your muscles. These are called ***motor neurons***, because they can signal your body to move. There is also a third set of neurons called ***associative neurons***. They are located in the brain and the spinal cord. They allow sensory nerve cells and motor neurons to communicate, or associate, with each other. Associative neurons make it possible for motor neurons to respond correctly to sensory neurons.

Nerves are found throughout your body. Each part of your body has a pathway of nerves to and from the brain. These pathways interconnect, like roads, so that, for example, messages from your fingers may share a nerve pathway after they reach the wrist. Also, one nerve may send messages to two or more structures at once, so that if one structure gets the message, the other always does, too. Some parts of the body have more sensory neurons than other parts. This is why we say some parts of the body are more *sensitive* than others.

IDENTIFY

In each case, tell whether the impulse for the action or feeling listed would be carried by a sensory neuron or a motor neuron. Put **S** for sensory and **M** for motor.

____ pain
____ seeing a dog
____ petting a dog
____ salivating
____ cold
____ hearing a bell
____ writing
____ an itch
____ scratching

SENSORY NEURONS

1. **Try the following experiment.**
   Equipment: two sharpened pencils

Set-up:
Have your partner close his eyes and turn his back to you, with the skin of his neck exposed.

Procedure:

a. Now take the two pencils and touch the neck with the points of the pencils, with the points about 3 inches apart.
b. Make sure the points touch the skin at the same time.
c. Ask your partner how many points he felt.
d. Now repeat the steps above, but move the points a little closer together.
e. Ask your partner again how many points he felt.
f. Continue the steps until your partner responds that he only felt 1 point.
g. How far apart were the pencils when your partner felt only one point? ____________
h. Now repeat the experiment above, only touch the palm of your partner's hand instead of the neck.
i. How far apart were the pencils when your partner felt only one point?
____

Analysis:
Compare the two results. On which part of the body were the pencil points the farthest apart when your partner only felt 1 point? ________ We would say that this part of the body is *less sensitive* than the other part. Sensory neurons are responsible for sending messages about things you feel on your skin. What does this experiment tell you about the sensory neurons in the neck and the palm of the hand? (Hint: Think about the number of neurons.) ______________________________
____

Try to guess other parts of the body that would be less sensitive than the palm of the hand. Make a list of the more sensitive areas of the human body.

THE CENTRAL NERVOUS SYSTEM

The ***central nervous system*** is the control center for the nervous system. All sensory impulses go to the central nervous system. All motor impulses begin in the central nervous system. The central nervous system contains two very important organs: the ***brain*** and the ***spinal cord.***

The brain has several different parts. Each part has a different function. The ***cerebrum*** is the biggest part of the brain. The cerebrum stores information. This is our memory! We use the stored information to think. The cerebrum also controls voluntary actions, like moving your hand. The ***cerebellum*** is the second largest part of the brain. The cerebellum makes muscle actions smooth. It makes coordinates our movements. Without the cerebellum, muscle movements would be very jerky and manual tasks would be difficult. The cerebellum's control of muscles is involuntary. The ***medulla*** is found at the bottom of the brain. It controls involuntary movements, such as breathing. The ***spinal cord*** is a long stem that extends from your brain all the way down your back. The spinal cord conducts messages to and from the brain. Reflex actions are also controlled by the spinal cord.

MATCHING

Draw lines connecting the parts of the central nervous system in the left column with the functions listed in the right column.

cerebellum

cerebrum

spinal cord

medulla

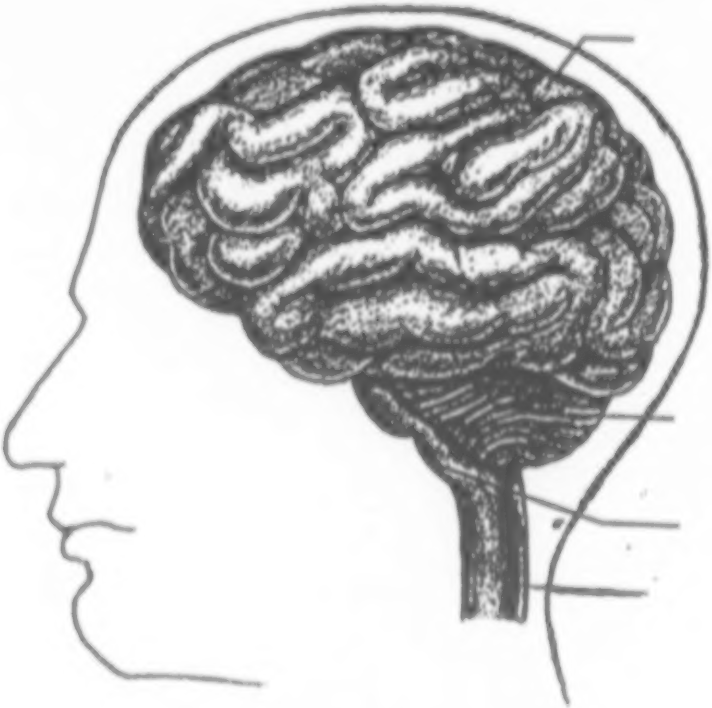
Controls involuntary activities, like breathing, stomach activities, etc.

Controls coordination of voluntary actions; also controls balance and equilibrium.

Controls all voluntary muscle movements; center for memory, thinking, learning, and interpretation of all sensory impulses that enter the brain.

Conducts impulses to and from the brain; controls simple reflexes

Identify the structures in the left column above on the diagram below.



VOLUNTARY VS. INVOLUNTARY ACTIONS

Human beings perform both voluntary actions and involuntary actions. Voluntary actions are actions that you have to want to do, or that you have control over, such as talking, raising your hand, or bending your knee. Nerves that control voluntary actions are called ***somatic*** nerves.

Involuntary actions are actions that your body does automatically, without you thinking about them. Keeping your heart beating and digesting food are two involuntary actions. Nerves that control involuntary actions are called ***autonomic*** nerves.

SYMPATHETIC VS. PARASYMPATHETIC

Autonomic nerves send messages to the organs and glands of the body. These actions cannot usually be controlled by thought. There are two types of autonomic nerves. One type, which is called the ***sympathetic*** division, takes control when you feel excited or when you are in danger. For example, the sympathetic division would tell your heart to beat faster, your respiratory system to breathe faster, and your stomach to stop digesting. The sympathetic division is sometimes called the "flight or fight" response. It stops certain body functions temporarily so that more energy and attention can be devoted to responding to the threat. This is why your heart beats faster when you are scared.

The other type tells the body to carry out body functions when you are not excited or scared. These nerves make up the ***parasympathetic*** division. For example, the parasympathetic division would tell your heart to beat normally, your respiratory system to breathe normally, and your stomach to digest food. The parasympathetic division controls normal functioning of the body. This division takes over when the threat is gone to return the body to normal.

IDENTIFY

Decide whether each action is controlled by somatic or autonomic nerves. If it is somatic, write an **S** next to the action. If it is autonomic, write **A**. Then decide whether it is controlled by the sympathetic or the parasympathetic division. If it is sympathetic, add **S** to the **A**. If it is parasympathetic, add **P** to the **A**.

____ writing

____ swallowing

____ pushing food through the esophagus

____ smiling

____ regular heartbeat

____ secretion of intestinal juice

____ quickened heartbeat

____ yawning

____ closing your eyes

____ salivating

____ crying

____ chewing

SEQUENCE

You see a man point a gun at you. You scream. You then realize the gun is a toy. You relax.

Below are the nervous system steps involved in the sequence of events above. The missing steps are listed on the next page. Put the missing steps in the proper places below.

1. Sensory neurons in the eyes detects the gun.
2. Sensory neurons of the peripheral nervous system conduct the impulse.
3.
4. The brain interprets the impulse.
5.
6. One set of impulses goes to the somatic nerves that control the muscles that control the vocal cords and you scream.
7.
8. Sensory neurons detect that the gun is a toy.
9.
10. The impulse reaches the brain in the central nervous system.
11.
12. The central nervous system sends 2 sets of impulses to the motor neurons of the peripheral nervous system.
13.
14. One set of impulses goes to the parasympathetic division of the autonomic nerves and your body functions return to normal.

Missing Steps:

a) Sensory neurons of the peripheral nervous system conduct the impulse.

b) The impulse reaches the brain in the central nervous system.

c) The brain interprets the impulse.

d) The central nervous system sends two sets of impulses to the motor neurons of the peripheral nervous system.

e) One set of impulses goes to the somatic nerves that control the muscles that control the vocal cords and you stop screaming.

f) One set of impulses goes to the sympathetic division of the autonomic nerves and your "fight or flight" response is activated (i.e., heartbeat quickens, etc.)

REFLEXES

Some "voluntary" movements are things you do without thinking about it. These actions are usually in response to something in the environment that surprises your system. The message to respond is sent to the muscles without you thinking about it. Some examples of reflexes are blinking when someone throws something at your face or quickly moving your hand when you touch something hot. Reflexes protect your body by responding quickly to dangerous situations.

A reflex is a very fast action. The sensory impulse is sent to your spinal cord. Instead of going to your brain, the response impulse is sent from the spinal cord to a motor neuron. This impulse tells the muscle to move. This pathway is called a ***reflex arc***.

SEQUENCE

Below are the steps that an impulse travels in a reflex action. Rewrite them in the correct order at the bottom of the page.

spinal cord

long end of a sensory neuron

long end of a motor neuron

long end of an associative neuron

short end of a sensory neuron

short end of a motor neuron

short end of an associative neuron

REFLEX EXPERIMENT

One reflex action is the opening and closing of the pupil of the eye in reaction to light. (The pupil is the black hole in the center of the eye.) When too much light is present, the pupil gets smaller. When too little light is present, the pupil gets larger. This is a way of adjusting the amount of light that reaches the eye.

Try the following experiment. Cover one eye. Have your partner watch what happens to the pupil of the uncovered eye.

1. What happened to the pupil of the uncovered eye?

2. What do you think happened to the pupil of the covered eye?

3. Did you expect the two eyes to react the same way?

4. Since the amount of light available to the uncovered eye did not change, why did the size of the pupil change?

5. Does this mean that the two eyes are on the same reflex arc or on different reflex arcs? Explain your answer.

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

Example:

1.	**cerebrum**	**cerebellum**
	spinal cord	**medulla**

All four of these are parts of the central nervous system. The spinal cord is the "odd word out" because it is not part of the brain while cerebrum, cerebellum, and medulla are.

2.	cerebrum	medulla
	somatic nerves	motor neuron

3.	motor neuron	brain
	associative neuron	spinal cord

4.	parasympathetic division	sympathetic division
	cerebellum	medulla

5.	long end of neuron	nucleus
	synapse	short end of neuron

PICTURE WORDS

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voluntary actions

spinal cord

cerebrum

nerve

SENSE ORGANS

The ***senses*** are how you find out what is going on around you. Your sense organs give you information about your environment. Humans have five senses: ***vision, hearing, taste, smell, and touch***. The ***eyes, ears, tongue, nose, and skin*** are sense organs. They each function to provide one of the senses.

ANALYZING THE SENSES

1. Why would it be a disadvantage to have the taste buds for bitter at the back of the tongue? (Hint: What types of foods are bitter?)

   a) Is it easier to avoid swallowing something at the back of the tongue or at the front of the tongue?

2. How does blinking help the eye?

3. Sometimes the bones in the ear get stiff and "calcified" — calcium builds up between the bones. How would this affect hearing? Can you think of ways to help the problem?

4. People who need glasses have a problem with the eye. Their eyes do not focus light on the retina properly. What structure of the eye do eyeglasses imitate or help?

5. People often get ear infections. Bacteria start to grow in the ear canal. The body's defenses fight the bacteria. This creates a thick liquid that blocks off the canal. How would this affect hearing?

6. What do you think the wax in the ear does?

THE ENDOCRINE SYSTEM

ENDOCRINE SYSTEM

Hormones are chemicals manufactured by the body to regulate functions such as metabolism, growth, and reproduction. Hormones are produced by structures called ***glands*** and are carried by the blood to the cells of the body. The system of hormone-producing glands is called the ***endocrine system***.

Endocrine glands are found in many different parts of the body. The thyroid gland, which regulates growth, is located in the neck. The pancreas, which produces insulin so the body can use sugar properly, is found in the abdomen. The ovaries and testes also produce female and male hormones. Glands release hormones directly into the blood stream, so the hormones come in contact with almost all the cells in the body. But most cells ignore the hormones; only the cells that the hormone is designed for can actually use the hormone. For example, only the cells that reflect sex characteristics respond to hormones produced by the ovaries or testes.

CHARACTERISTICS OF THE ENDOCRINE SYSTEM

Put a check mark next to the statements that are true of the endocrine system.

___ Has a specialized network of tubes to carry hormones to body organs

___ Consists of one gland

___ Secretes hormones into the blood stream

___ Sends hormones only to the target cell

___ Endocrine glands are connected to each other

___ Endocrine glands are found in many different parts of the body

___ All hormones have the same effect on body organs

___ Hormones can affect muscles

___ Hormones usually affect all the cells they come in contact with

___ Hormones can affect cell metabolism

PICTURE WORDS

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thyroid gland

endocrine system

THE EFFECTS OF HORMONES

1. When the *pituitary gland* is removed from an animal, the level of many hormones in the blood falls. However, we know that the pituitary gland ***does not*** produce the hormones that are missing. **What is the function of the hormones of the pituitary gland?**

2. The female body produces testosterone, the hormone that produces male characteristics (like a beard or a low voice). The female body also produces estrogen, a hormone that produces female characteristics (like smooth skin, breast development, no voice change).
   a) If the ovaries, which secrete estrogen, are removed, what would happen to the woman?

   b) What could be done to stop this from happening?

3. When the *parathyroid gland* is removed from an animal, the amount of calcium in the blood decreases steadily, no matter how much calcium is in the diet.
   a) What cells of the body do you think the hormones of the parathyroid gland affect?

AN EXPERIMENT

Examine the experimental results below and answer the questions that follow.

There are two types of pea plants, dwarf and normal. Dwarf pea plants grow only 1/4 as tall as normal pea plants. In this experiment, a set of four types of plants were grown from seeds. One set of dwarf plants was treated with the chemical *giberillin*. One set of normal plants was treated with giberillin. A set of dwarf plants and a set of normal plants were grown without giberillin. The table below lists the average heights of the plants in each category on certain days.

PLANT	DAY 5	DAY 10	DAY 15
Dwarf + Gib.	2.5cm	7.2cm	15.6cm
Dwarf	1.0cm	3.1cm	5.7cm
Normal + Gib	2.3cm	7.4cm	15.8cm
Normal	2.6cm	7.0cm	15.6cm

1. Which plants showed similar growth patterns?

2. Would you say the giberillin caused the normal plant to grow more? Why or why not?

3. What do you think giberillin is?

4. What do you think is the difference between dwarf and normal varieties of pea plants?

5. What plants were the control for the experiment? Could you draw conclusions if you hadn't used controls? Explain your answer. (Refer to the Science Methods unit, p. 5, for information on controls.)

6. In what way is giberillin similar to human growth hormone? In what ways is it different?

INSULIN

Insulin is a hormone that allows your body to take sugar out of the blood and into the cells.

1. What would happen if your body didn't produce enough insulin?

2. What would happen if your body produced too much insulin?

3. How could you help people who don't produce enough insulin?

REPRODUCTION

REPRODUCTIVE SYSTEM

Reproduction means having babies — that is, an adult organism creates a new organism like itself. All living things reproduce, whether they are plants, animals, or bacteria; whether they are made up of one cell or many cells. Reproduction is a way of making sure that a species will continue to exist. If a species stops reproducing, no young animals will replace the older ones when they die, and the species will become extinct.

There are two basic types of reproduction — ***sexual reproduction*** and ***asexual reproduction***. In sexual reproduction a male and a female of the species each contribute 1/2 of the chromosomes needed to create the new organism. In asexual reproduction the young organism receives all its chromosomes from only one adult organism.

FERTILIZATION

Fertilization is the combining of sperm and egg to form an ***embryo***. The embryo will develop into a new organism. Fertilization can occur inside the female's body or outside the female's body. The embryo may develop inside the female's body or outside. Where fertilization occurs and where the embryo develops have a great effect on the number of eggs the female produces.

External fertilization occurs primarily in certain animals that live in or near the water. The female releases eggs into the water. The male releases sperm. But it may be difficult for the sperm to find the eggs and fertilize them. Many of the sperm and eggs die before they ever get together. Also the eggs do not have much protection from the environment. They may be killed by heat or cold, or eaten by other animals. For these reasons, the female must lay hundreds or even thousands of eggs to make sure that a few of them will survive, be fertilized, and mature.

Internal fertilization makes it easier for the sperm to reach the egg, since the sperm is released inside the female's body, near the eggs. For this reason the female does not have to release as many eggs as a female who reproduces by external fertilization would have to release. But when the female lays the fertilized eggs so that they can develop outside her body, the eggs face the same dangers as eggs fertilized externally.

Some animals that reproduce by internal fertilization do not lay eggs. In these animals, the female keeps the fertilized eggs inside her body during their most important period of development. This protects the young animal from dangers that could harm its growth. Because the egg is so well protected, females that reproduce this way provide very few eggs — sometimes only one. The chances are very good that the fertilized egg will survive.

Sexual Reproduction in Most Mammals — Internal Fertilization

1. ***Eggs*** are produced in the ***ovaries*** of the female mammal.

2. ***Sperm*** are produced in the ***testes*** of the male mammal.

3. The eggs move into ***tubes*** attached to the ovaries.

4. The ***penis*** is placed into the ***vagina***.

5. Sperm travel from the testes through the penis. The penis releases sperm into the vagina.

6. Sperm swim from the vagina into the ***uterus*** and then into the tubes.

7. One sperm joins each egg in the tube. This is ***fertilization.***

8. The fertilized eggs move from the tubes into the uterus.

9. The fertilized eggs attach themselves to the wall of the uterus.

10. After the embryos (fertilized eggs in the uterus) have grown into complete animals, they are released from the female's body. This is called ***birth***.

SEQUENCE

Below are the steps for reproduction in mammals. Number the steps in the order they occur.

____ Eggs are released from the ovary.

____ Sperm swim from the vagina into the uterus and then into the tubes.

____ Sperm are produced in the testes of the male and eggs are produced in the ovaries of the female.

____ The fertilized eggs attach themselves to the wall of the uterus.

____ The eggs move into tubes attached to the ovaries.

____ One sperm joins each egg in the tube. This is fertilization.

____ The fertilized eggs move from the tubes into the uterus.

____ The penis is placed into the vagina.

____ The embryos develop inside the uterus.

____ Sperm travel from the testes through the penis.

____ The developed embryo is released from the female's body.

____ The penis releases sperm into the vagina.

WHAT IS MEIOSIS?

Most many-celled plants and animals do not reproduce asexually. They reproduce sexually — that is, sperm cells from a male and egg cells from a female must join before a new organism is produced. Each sex cell — the sperm and the egg — has half of the necessary ***chromosomes*** (genetic information) to form a new organism. When the sperm and egg join each other, the two half sets of chromosomes are combined. So the new organism has a full set of chromosomes with one-half of coming from each parent (each of the original cells).

MEIOSIS

1. The chromosomes inside a cell duplicate and get shorter and thicker. Two complete sets of genetic material are now present in the cell.

2. The original and the copy for each chromosome are joined at the center (as in mitosis).

3. Remember that each chromosome originally had a ***homologous*** "partner" chromosome that contained genes that coded for the same information. The original and copy of each chromosome (still attached at the center) lines up with its homologous partner chromosome (which is also an original and a copy joined together) at the middle of the cell.

4. ***Spindle fibers*** are formed from the ends of the cell to the middle.

5. The homologous partners move to opposite ends of the cell. The original and copy *do not* separate as they did in mitosis, but remain attached and move to the same end.

6. The spindle fibers disappear and a nuclear membrane may form around the chromosome clumps at the poles.

7. The ***cytoplasm*** divides, leaving two cells. Each cell contains an original and a copy of only **1** chromosome from each homologous pair. Therefore, the new cells contain only *half* the number of chromosomes the original cell had, but the new cells have two copies each of these chromosomes.

8. The chromosomes in both of the two new cells again become shorter and thicker.

9. The nuclear membrane disappears.

10. The spindle fibers are formed. The chromosomes line up on the equator.

11. The replicated pairs separate at the center and move to opposite ends of the cell so that the original chromosome and the copy are now at opposite ends.

12. The spindle fibers disappear.

13. A nuclear membrane develops around the clump of chromosomes.

14. The cytoplasm divides and a total of 4 new cells have been produced from the 1 original cell. The resulting cells have *half* the number of chromosomes the original cell had. This is called ***haploid***.

15. The cells formed from meiosis are the gametes which are involved in sexual reproduction. When two haploid cells combine, each having a *half* set of chromosomes, the resulting cell has a *full* set of chromosomes. This is what happens when a sperm and an egg combine to form an ***embryo.***

COMPARING MEIOSIS AND MITOSIS

Complete the chart below. It lists differences and similarities between mitosis and meiosis.

MEIOSIS	MITOSIS
Chromosomes duplicate.	Chromosomes ______________.
Nuclear membrane disappears	________________________.
Homologous pairs of chromosomes line up at the center of the cell.	Homologous pairs of chromosomes _________ line up at the center.
Replicated pairs do not separate.	Replicated pairs ______________.
Homologous pairs separate and move to opposite ends of the cell.	
New nuclear membranes *may* form around chromosome clumps.	New nuclear membranes ________ ________________________.
Two new cells result as a *temporary* stage in meiosis.	___ new cells result. This is the final product of______________.
The two new cells have _________ the number of chromosomes as the parent cell.	The two new cells have _________ number of chromosomes as the parent cell.
The two new cells repeat the steps of ***mitosis*** except the chromosomes do not duplicate.	
A final total of ___ haploid cells result from meiosis.	________________________ ________________________.

Sexual Reproduction In Flowering Plants

1. ***Eggs*** are produced in the ***ovary*** of the flower.
2. ***Sperm*** are produced in the ***anther*** of the flower. Sperm are found in ***pollen grains*** (2 sperm in each grain).
3. Wind, insects, or other animals carry a pollen grain from the anther to the ***stigma*** (the sticky surface at the top of the style) of the flower. This movement is called ***pollination***.
4. The pollen grain forms a tube which grows from the top of the style down toward the ovary. There are two sperm in the tube.
5. When the tube reaches the ovary, the two sperm enter the ovary.
6. One sperm joins an egg in the ovary. This is called ***fertilization***.
7. The second sperm joins special cells surrounding the egg to make a food supply for the egg.
8. The ***embryo*** (fertilized egg) and its food cells together are called the ***seed***. The seed goes dormant (it does not develop anymore). The seed will use its food and begin to develop again when it is is under favorable conditions.

POLLINATION

Pollination is the transfer of the pollen from the anthers of one flower to the stigma of another flower. This is a very important step in sexual reproduction in flowering plants. There are two basic methods for pollination. 1) In ***wind pollination*** the wind carries the pollen from the anther of the flower. Some of the pollen may land on the stigma of a compatible flower. 2) In ***animal pollination*** an insect, bat, or bird may land on a flower, usually to get ***nectar*** (a sweet substance produced by flowers). The pollen becomes stuck to the legs or body of the animal. When the animal flies to another flower, the pollen is transferred and may land on the stigma of a compatible flower.

POLLINATION

Below are descriptions of some flowers. For each, decide whether it probably uses wind pollination or animal pollination.

1. A plant has small flowers with very small petals and sepals. The petals are white. The pistils and stamens are very long. They stick out past the petals. The flowers are clustered near the ends of branches.

   a) What method of pollination would you guess this plant uses?

   b) Why?

   c) How does the structure of the flower help in this method of pollination?

2. A plant has very colorful flowers. The petals are brightly colored and rather large. The bottom petals are flattened into a broad, flat surface. The flower has a pleasant odor. The stamens are in a circle around the pistil. The stamens are fairly short and do not stick out past the petals. The anthers hang near the nectar producing structures of the flower.

   a) What method of pollination would you guess this plant used?

   b) Why?

   c) How does the structure of the flower help in this type of pollination?

   d) How does the odor and color of the flower affect pollination?

ASEXUAL REPRODUCTION

In ***asexual reproduction***, one organism produces another organism just like itself. Sex cells are not involved. Cells do not have to go through meiosis. This makes reproduction easier. However, since the new organism is just like the parent, there is no genetic variation. Asexual reproduction usually occurs in small organisms that are not very complex. Some organisms reproduce asexually and sexually.

There are several types of asexual reproduction. ***Binary fission*** is a type of asexual reproduction used by some one-celled organisms. Binary fission is like mitosis. The cell duplicates its chromosomes and then divides into two new cells. ***Budding*** is a type of asexual reproduction found in both one-celled organisms and many-celled organisms. The organism begins to grow a small "bump" on the outside. The bump looks like the adult. After the bump reaches a certain size, it falls off and becomes a new organism. ***Regeneration***, also called ***vegetative reproduction***, is a type of asexual reproduction found in many-celled organisms. The organism simply breaks off part of its body. This broken part grows into a new organism. The missing part is regrown on the parent organism. Some organisms split in half and each grows into a whole organism. Finally, ***sporulation*** is another type of asexual reproduction. It can occur in one-celled or many-celled organisms. The organism, usually fungi and some plants, produce ***spores***. Spores are small, hard grains similar to seeds. The spores are released from the parent. Each spore can become a new organism. Spores sound very similar to seeds. But remember that seeds are produced from sexual reproduction.

MATCHING

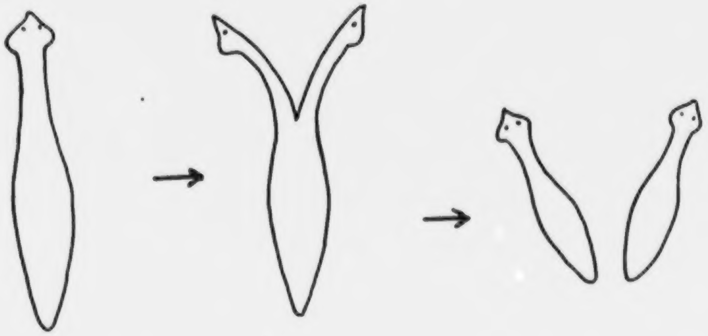
Match the types of asexual reproduction listed in the left column with the pictures in the right column.

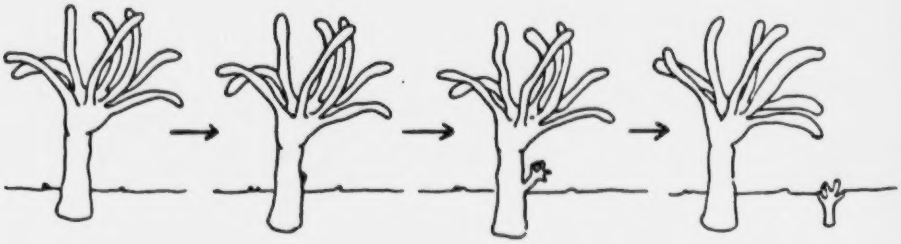
Budding

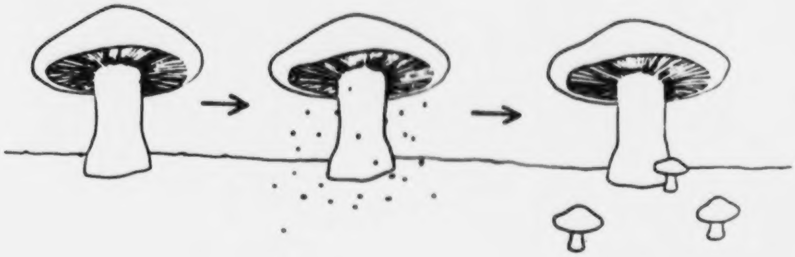
Binary Fission

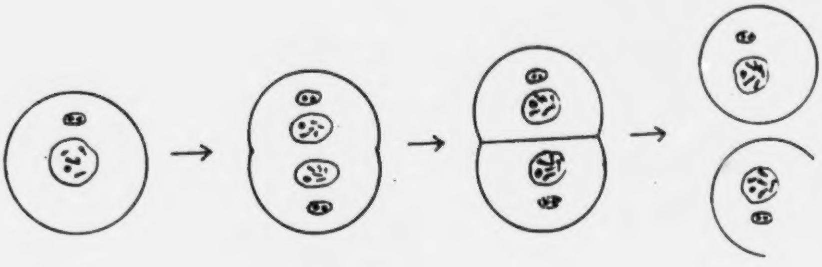
Regeneration

Sporulation









IDENTIFYING TYPES OF ASEXUAL REPRODUCTION

Read the paragraphs below. Each describes an organism and its type of asexual reproduction. Write the name of the type of asexual reproduction in the space provided.

1. The hydra is an animal that can reproduce asexually. The parent hydra produces tiny organisms just like itself that grow out of its side. After the tiny organism has reached a certain size, it falls off and becomes an independent animal. ____________________

2. Bread molds usually reproduce asexually. A special structure at the tip of the mold stores spores, one-celled structures that are capable of surviving independently for a long time without any food. These spores are released from the mold. When they land in a good place (one with food and water), the spores begin to grow into another mold.

   ____

3. *Escheria coli* is a bacteria that lives in the intestines. To reproduce, it makes a copy of its chromosome. It then divides itself into two equal parts, each with a copy of the chromosome. This leaves two new, complete *Escheria coli* bacteria. ____________________

4. A planaria is an animal that may sometimes reproduce asexually by spontaneously splitting down the middle. Each half then grows into a complete planaria. ____________________

5. Many fungi reproduce asexually. Part of the "branch" of the fungus breaks off. The piece grows into a new fungus. ____________________

COMPARING SEXUAL AND ASEXUAL REPRODUCTION

Read the statements below. Decide whether each statement applies to sexual reproduction, asexual reproduction, both, or neither. Put an S (for sexual), A (for asexual), N (for neither), or B (for both) in the space provided.

____ Gametes are produced.

____ Offspring have a genetic code identical to the parent.

____ An offspring of the same species as the parent is produced.

____ The offspring are genetically different from the parents.

____ Two organisms are usually involved.

____ The parent may be reduced in size after producing offspring.

____ The offspring must go through development stages before becoming an adult.

____ Only one organism is ever involved.

____ Meiosis occurs.

____ Genetic variation always occurs.

ODD WORD OUT

Three of the words in each group have a common characteristic. Circle the word in each group that doesn't belong. Explain your answer by telling what the three words have in common.

1. meiosis four cells
   two cells haploid

2. embryo egg
   sperm pollen

3. budding fertilization
   binary fission regeneration

4. insects bats
   birds wind

PICTURE WORDS

Below is a list of words or phrases from this unit. Your partner has a different list of words. Your job is to get your partner to guess the words on your list. You do this by drawing pictures. You cannot write letters or words. You may draw one picture for the word or a series of pictures for the word. You and your partner should take turns guessing and drawing until you have guessed all the words on both lists.

external fertilization

pollen

INTEGRATED SYSTEMS

INTEGRATED SYSTEMS

By now, you have studied the 9 organ systems of the human body. You should know how each system works. However, it is important to realize that no system works completely independently. Every system depends on the proper functioning of the other systems. To understand completely how the body functions, you must think about how the systems work together as a team. The following questions concern all the organ systems and how they interrelate.

MATCHING

Match the systems listed in the left column with their primary function in the middle column, and with the primary organ involved, listed in the right column.

Pumps blood and distributes it throughout the body. Carries many substances to the cells.	Digestive	kidneys
Removes waste products from the body	Circulatory	glands
Takes in and processes food for use as energy	Respiratory	heart
Supports and protects the body organs and aids in movement	Excretory	brain
Brings oxygen into the body so it may be distributed to the cells	Nervous	intestines
Receives messages from the body and environment and controls the body's responses	Muscular	lungs
Responsible for movement	Skeletal	bones
Controls some body functions through the regulated release of chemicals into the blood	Endocrine	muscles

For each system listed, check the systems underneath that are directly involved in the functioning of the first system. (Note that all systems are vital for life. Check only the systems that are involved in normal functioning. That is, don't check respiration for all the systems just because oxygen is necessary for anything in the body to work.)

Example:

1. DIGESTIVE SYSTEM

X circulatory
__ endocrine
__ respiratory
X muscular
__ skeletal
__ excretory

The circulatory system is necessary to transport the nutrients from the intestines. Muscles are responsible for moving food through the digestive system.

2. CIRCULATORY SYSTEM

__ digestive
__ muscular
__ skeletal
__ respiratory
__ endocrine

3. NERVOUS SYSTEM

__ circulatory
__ digestive
__ respiratory
__ skeletal

4. RESPIRATORY SYSTEM

__ digestive
__ circulatory
__ muscular
__ nervous

5. ENDOCRINE SYSTEM

__ circulatory
__ digestive
__ nervous
__ reproductive

6. MUSCULAR SYSTEM

__ skeletal
__ excretory
__ nervous
__ reproductive

GUESS THE CATEGORY

Some categories are listed below. Your job is to list things that fit into that category for your partner. Some examples of things you could list are given after each category. Your partner will try to guess the category. See how many categories your partner can guess in 1 minute.

1. Places you can find blood cells
   - urine
   - bone marrow
   - blood

2. Places you find oxygenated blood
   - right atrium
   - pulmonary vein

3. Body Systems
   - Circulatory
   - Digestive
   - Nervous

4. Reflex reactions
   - blinking
   - kicking your leg when the knee is hit

Below are ten words. They are in alphabetical order. Give your partner short clues for each word to help him/her guess them. If your partner is having trouble, you may skip a word and come back to it. Try to get all the words in less than 1 minute. Your partner knows the first letter of each word. Tell him when he guesses the correct word.

EXAMPLE: A - Artery Clue: Blood vessels that carry blood to the heart.

L	**M**	**N**	**O**	**P**	**R**	**S**
ligaments	medulla	nutrients	oxygen	platelets	reflex	sperm

T	**U**	**V**
thyroid	uterus	veins

The words in your partner's book start with the following letters, in this order:

B C D E F G H I J K

SYSTEMS INVOLVED

After each description, list the systems that are involved in the situation described. Briefly tell how each system is involved.

1. Juan eats a candy bar and his body uses it for energy.

2. Carol throws a baseball toward home plate.

3. Marie's body is able to fight off a bacterial infection.

4. Jane's ovaries release a mature egg cell.

5. Jim deeply breathes in the clean, mountain air.

SYSTEM SIMILARITIES

1. List all the systems that use diffusion in performing their functions.

2. List all the systems that use the circulatory system to perform their function.

3. List all the systems that include some type of tube structure. Is there a similarity in the functions of these systems?

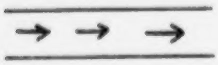
4. List all the systems that take some product from outside the body and bring it into the body.

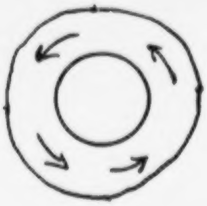
5. List all the systems that expel something from the body.

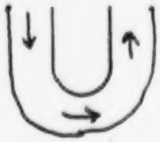
ONE WAY STREET OR A DEAD END?

Many systems transport substances and messages throughout the body. There are two major types of transportation pathways.

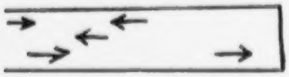
1) **One-Way Transport** — Substances may move in only one direction along the pathway. This is much like a one-way street. The shape of the street is not what matters. What is important is that traffic goes only one way.

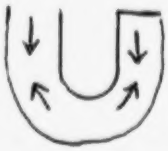






2) **Dead End Transport** — Substances can move in either direction along a pathway (in or out). This is like a dead end street, where cars can go either direction, driving anywhere on the road, but they must exit the way they entered.





Classify the following systems of human beings into one of the two categories above. Explain your answers.

Digestive
Circulatory
Respiratory
Excretory
Nervous

Which seems most efficient, one-way or dead end? Why?

ANIMAL VARIATIONS

1. In most animals, the respiratory system and the digestive system share some structures, like the mouth and the pharynx. The *lamprey* is a fish that is a parasite. The lamprey attaches its whole mouth to the side of a big fish and sucks the fish's blood to get nutrients.
   a) Do you think the lamprey's respiratory system and digestive system share any common structures?

   b) Why or why not?

2. Clams often live buried many centimeters under the ocean floor. They filter food and oxygen from the ocean water. Long tubes go from the clam's body to the water. The tubes bring in water and then expel it. Do you think the respiratory and digestive systems share the water from the same tubes? Why or why not?

3. In animals, skin may serve several different purposes. What are they? What different organ systems could skin belong to?

YOU'RE THE DOCTOR

Below are descriptions of patients that have come to see you. Use your knowledge of the body systems to diagnose the problem. In some cases, it may be necessary to have medical tests performed to diagnose the problem. You may request the results of specific tests. Your partner has the results.

The possible tests are
- **a) blood analysis**
- **b) urine analysis**
- **c) listen to heartbeat**
- **d) check for clogged arteries and veins**

1. The patient has difficulty performing manual tasks, such as walking or talking, smoothly. Movements are jerky and uncoordinated. What body system do you think is causing the problem? What specific structure is probably injured?

2. The patient is generally weak. Breathing is not difficult, but the number of breaths per minute is higher than normal. There is pain in the left side of the chest. Some fluid is found in the alveoli of the lungs. What system is causing the problem? What things would you check? What structure is not performing correctly? (Be specific).

3. The patient has a high breathing rate and general weakness and dizziness. Rate of heart beat is also increased. What else would you check?

   What structure is probably malfunctioning?

4. The patient is very thin, even though he is eating normally. The patient is also very tired. What tests would you perform?

Based on these results, what do you think is the problem?

5. The patient has severe pain in the lower back, near the left side. Urine production is low. What test would you perform?

What might be causing the low urine output, the pain, and the results of the test?

6. The patient has several broken bones. The bones broke very easily. What might be causing the "brittle bones"? What test could you run?

OCCUPATIONAL HAZARDS

Many jobs can be harmful to your health. Different jobs have different risks. These risks are called ***occupational hazards***. Read the job descriptions below and tell which systems you think would be most affected by each job.

1. Football Player — A football player goes through intensive physical training through most of the year to build muscles and strengthen bones. During football season, the football player performs strenuous physical activity every week. The player is often hit and bruised by other players.

2. Coal Miner — A coal miner works deep underground digging coal. The air underground is very thick with small particles of dust and coal. Also, some poisonous gases may be present in the mine.

3. Boxer — Boxers go through intensive physical training throughout the year to keep their bodies in good shape. During a boxing match, a boxer is usually hit many times, often in the head. The object of a boxing match is to knock your opponent unconscious.

4. Pianist — A pianist must practice playing the piano for many hours each day. The pianist moves her fingers over and over in the same way.

FUNNY PHRASES

Below are some sentences. These sentences contain phrases that use terms related to body systems. These are phrases used in everyday conversation. They often don't mean what they seem to mean or don't seem to make any sense at all. See if you can guess what each one means. How is the meaning of the phrase related to the function of the body part or system mentioned?

1. The violence in the movie *turned my stomach.*
2. Before I gave the speech, I had *butterflies in my stomach.*
3. I found John's explanation *hard to swallow.*
4. *Don't bite off more than you can chew.*
5. When the movie ended, my *heart was in my mouth.*
6. Tarey's *heart stood still* while they announced the winner.
7. The nominee's speech *made my blood boil.*
8. I can't *catch my breath.*
9. Jeff gave the answer *at the top of his lungs.*
10. Don't *rack your brains* for the answer.
11. The movie was *spine-tingling.*
12. Have you *moved a muscle* since I left?
13. Maria is just *skin and bones.*
14. Don't get your *nose out of joint* over Jane's comments.
15. I may not know everything, but *I wasn't born yesterday.*

Can you think of any other phrases like these that refer to body parts?

GENETICS

GENETICS

A ***trait*** is a characteristic of a living thing. Your height, your blood type, and the shape of your ears are all examples of traits. Traits are ***inherited,*** that is they are passed from parents to their offspring. The study of how traits are inherited is called ***genetics.***

Every species of living thing has a specific number of chromosomes. Human beings have 23 chromosome pairs, for a total of 46 chromosomes. Every cell in the body has these 46 chromosomes, because these chromosomes carry the information that the cells need to function and reproduce. The only exceptions are the sex cells (egg and sperm) which have only 1 member of each chromosome pair, for a total of 23 chromosomes each. (Of course, when a sperm fertilizes an egg, this brings the chromosome count up to 46 again.)

The ***chromosomes*** in the nucleus of the cell contain the genetic information which determines traits. Chromosomes are made up of a substance called ***DNA*** (deoxyribonucleic acid). DNA is made up of several different chemicals and has an extremely complicated structure. The chemicals along the chromosome are arranged in special sequences called ***genes***, much like the letters in a sentence are arranged in special sequences called words.

Each gene determines a specific trait, and genes found on the same chromosome are normally inherited together. For example, in the fruit fly, the gene for eye color and the gene for wing shape are found on the same chromosome, so if a fly has eyes the same color as its mother, it will probably have wings the same shape as the mother.

Some traits are more likely to appear than other traits. For example, every child receives one gene for eye color from his mother and one gene for eye color from his father. If the mother's gene is for "blue" and the father's gene is for "brown", the child's eyes will be brown. We say that "brown eyes" is ***dominant*** (determined by a ***dominant gene***) and "blue eyes" is ***recessive*** (determined by a ***recessive gene)***. A child can have blue eyes only if the mother's eye-color gene and the father's eye-color gene are both coded for "blue."

Sometimes neither gene is dominant. This is called ***codominance***. The two traits may combine. For example, a red flower mated with a white flower could produce pink flowers. Sometimes *both* traits show. For example, a person with type A blood who marries a person with type B blood could produce children with type AB blood.

DESCRIBING TRAITS AND GENES

When we are describing someone, we can either talk about their physical characteristics or their genetic makeup. The physical traits of a person are called the person's ***phenotype***. For example, blue eyes is a phenotype. The genes that code for the traits are called the ***genotype***. For example, the genes **bb** code for blue eyes. It is important to talk about this difference because people with the same phenotype (physical traits) do not always have the same genotype (genes).

There are two possible genotypes for a trait. Remember that we get one set of genes from each parent. So we have two genes for every trait. If your mother has blue eyes, she gives you the gene **b** for blue eyes. If your father also has blue eyes, he gives you the gene **b** for blue eyes. You then have the genes **bb** for blue eyes. This is called ***homozygous***. Homozygous means when both your genes for a trait are the same. But suppose your father had brown eyes. He could give you the gene **B** for brown eyes. In this case, you would have the genes **Bb**. This is called ***heterozygous***. Heterozygous means the two genes for a trait are *not* the same.

SIZE

Rank the following particles in order of decreasing size.

___ chromosome

___ nucleotide

___ gene

___ DNA

CHROMOSOME NUMBER

Answer the following questions about chromosome number.

1. Which would have more chromosomes?
   a) a sperm cell
   b) a blood cell
   c) an egg cell

2. Which would have more chromosomes?
   a) a fertilized egg cell
   b) a sperm cell
   c) an egg cell

3. Human body cells have 23 ***pairs*** of chromosomes.
   a) How many total chromosomes is this? ____________
   b) How many chromosomes would a sperm cell have? ____
   c) How many chromosomes would an egg cell have? ____
   d) How many chromosomes would a fertilized egg cell have? ____

PHENOTYPE VS. GENOTYPE

Place a P next to the descriptions of phenotype and a G next to the descriptions of genotype.

___ A man has 6 fingers.

___ A man has the gene for 6 fingers

___ The flower is purple

___ The flower is heterozygous for purple

___ The mutant gene for short wings is present

___ The bacteria produces lactic acid

___ The boy looks like his father

True or False

___ 1. Two organisms with different genotypes always have different phenotypes.

___ 2. Two organisms with the same genotype usually have the same phenotype.

___ 3. Two organisms with the same phenotype usually have the same genotype.

GAMETES AND GENOTYPE

In each case, give the possible genotypes of the gamete.

Example:

1. Parent: Dd
Gametes: D or d

2. Parent: DD
Gametes:

3. Parent: DD Tt
Gametes:

4. Parent: Dd Tt
Gametes:

5. Parent: dd Tt Rr Yy
Gametes:

Fill in the missing genotypes.

Father: Dd Mother: dd
Sperm: ___ Egg: ___
___

Fertilized egg:
___ ___

Father: DdTt Mother: ddTT
Sperm: ___ Egg: ___
___
___
___

Fertilized egg:
___ ___ ___ ___

GAMETES

Which of the following genotypes would produce the greatest number of *different* gametes?

1. AAWWZz
2. aawwZz
3. Aawwzz
4. AaWwzz
5. AAWWZZ

RECESSIVE VS. DOMINANT

Put an R next to statements about recessive genes. Put a D next to statements about dominant genes.

___ Two of the gene are necessary for the phenotype to be present.

___ One of the gene is necessary for the phenotype to be present.

___ The gene may be present without the physical characteristic showing.

___ If the gene is present, the physical characteristic will show.

___ A capital letter is usually used to represent the gene.

___ A lower case letter is usually used to represent the gene.

MATING RABBITS

The gene **D** codes for dark hair and the gene **d** codes for light hair in rabbits.
The gene **T** codes for tough hair and the gene **t** codes for soft hair in rabbits.

Fill in the missing genotypes below.

Father:

Mother:

Sperm: DT or Dt

Egg: dT or dt

Complete a Punnett Square for the mating above.

	dT	dt
DT		
Dt		

Rewrite the possible genotypes of the offspring in the blanks below.

____ ____ ____ ____

For each genotype, tell what the phenotype would be.

PUNNETT SQUARE

In dogs, dark hair (D) is dominant over light hair (d). Short hair (S) is dominant over long hair (s). A female dog with white, long hair mates with a male dog with dark, short hair (DdSs). Draw a Punnett Square to find out what genotypes their puppies could have.

Write the phenotypes for each of the genotypes above.

PARENTS AND OFFSPRING

The gene **S** codes for straight wings and the gene **s** codes for crooked wings. The gene **R** codes for rough eyes and the gene **r** codes for smooth eyes.

Below are the genotypes of the mother and father fly. Fill in the genotypes of the sperm, egg and fertilized egg.

First Generation

Father: SSRR | Mother: ssrr
Sperm: | Egg:

Fertilized egg:

A) What is the phenotype of the father?
B) What is the phenotype of the mother?
C) What is the phenotype of the baby fly?

Second Generation

Two of the baby flies mate with each other. Write their genotypes. Also fill in the possible genotypes of the sperm and egg.

Father: | Mother:
Sperm: | Egg:

Third Generation

Use a Punnett Square to find all the possible combinations of their offspring then answer the questions on the next page.

A) What proportion of these offspring (third generation) will *look* like their parents (second generation)?

B) What proportion of these offspring (3rd generation) will *look* like their **grandmother** (1st generation)?

C) How many have straight wings and smooth eyes?

D) How many have crooked wings and rough eyes?

E) How many different genotypes produce straight wings and rough eyes?

RECESSIVE & DOMINANT

1. An albino is a person without any coloring. The hair is white and the eyes are pink. Albinism is carried by a recessive gene. A man and a woman are both heterozygous (Aa) for albinism.

   a) What are the chances that some of their children will be albino?

   b) Will any of their children be normal?

   c) Are the parents albino?

2. Can it be proven (without looking at gene sequences directly) that an animal is *not* heterozygous for a recessive gene? Explain your answer.

3. A man and a woman both have blue eyes, a recessive trait.
   a) Will any of their children have blue eyes? Explain

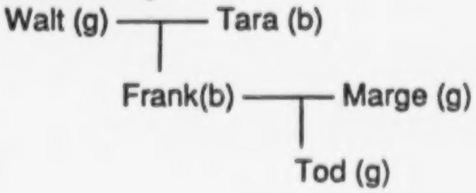
   b) Will any of their children have brown eyes? Explain

4. Some people have a gene that codes for very short fingers. Celeste is a woman who has short fingers. She marries John, a man who has normal fingers. They have six children. All of the children have short fingers.
   a) Do you think the gene for short fingers is dominant or recessive?

   b) Is the gene for normal fingers dominant or recessive?

   c) Explain your reasoning for both answers.

5. Walt has green eyes. He marries Tara, who has brown eyes. They have 8 children. All of the children have brown eyes. One of the sons, Frank, marries Marge, who has green eyes. Their son, Tod, also has green eyes. Answer the following questions. Explain your reasoning.
   a) Do you think green eyes is dominant or recessive?



   b) What do you think Tara's genotype is?

   c) What do you think Frank's genotype is?

   d) What do you think Tod's genotype is?

6. John goes on a hike through the woods. He comes across a violet with red flowers. Violets usually have purple flowers.
   a) How could John test to find out if the gene for red flowers is dominant or recessive?

John takes the plant home and grows it. He self-pollinates the plant (both gametes come from the same plant). All of the flowers grown from the seeds are red.

a) Does this tell you whether the red gene is dominant or recessive?

b) Can you tell if the plant is homozygous or heterozygous?

HOMOZYGOUS & HETEROZYGOUS

1. Genetics is used in animal breeding. Animal breeders want their animals to be "pure" stock.
   a) What do you think they mean by pure?

   b) What genotype do they mean?

   c) Why wouldn't they want "unpure" stock?

2. People who do not have a certain genetic disease, but who's offspring can have the disease, are known as carriers.
   a) Why do you think we call them carriers?

   b) Is their genotype homozygous or heterozygous for the disease-causing gene?

   c) Do you think the disease-causing gene is dominant or recessive?

THE GENE POOL

1. These two traits are dominant traits.
   Six-fingers Short fingers

   If these traits are dominant, why don't most people have these traits?

2. A certain dominant gene, **Z**, causes a deadly disease. People with this disease usually die before age 20. Do you think this gene will become common in the gene pool? Why or why not?

3. The dominant gene **W** also causes a deadly disease. People with this disease usually develop symptoms around age 45 and die by age 50. Do you think this gene will become common in the gene pool? Why or why not?

BLOOD TYPES

There are three types of genes for blood type. I^A and I^B are codominant. I^O is recessive. Below are possible genotypes and the blood type for each.

I^AI^A=Type A
I^AI^O=Type A
I^BI^B=Type B
I^BI^O=Type B
I^AI^B=Type AB
I^OI^O=Type O

1. Here are the blood types of two mothers, two babies, and two fathers. See if you can match the babies with the right parents.

Mother1: A Mother 2: AB
Father1: B Father 2: O

Babies: O and B

2. You are a veterinarian. Mr. James and Ms. Crowley come to you with a problem. Mr. James' horse just gave birth to a foal. He sold the foal for $100,000. Ms. Crowley claims her horse was the father of the foal. Ms. Crowley wants half the money. Below are the blood types of the foal, the mother, and Ms. Crowley's horse. Does Ms. Crowley have a right to the money?

First, fill in the possible genotypes for each horse.

	Blood Types	Possible Genotypes
Mother horse:	A	
Foal:	O	
Ms. Crowley's horse:	AB	

Could Ms. Crowley's horse be the father?

Can you know for sure what the mother's genotype is by looking at the baby's blood type?

CO-DOMINANCE

Petunias are plants with big, colorful flowers. You have a red-flowered petunia and a white-flowered petunia. You know that they are both homozygous. You also know that red (C^R) and white (C^W) are co-dominant. You cross-pollinate the red and white plants.

A) What are the genotype and phenotype of the offspring?

B) Now you cross two of the offspring plants. Draw a Punnett Square to find the genotypes and phenotypes of the offspring.

Gametes:

C) How many of the offspring are white?

D) How many of the offspring are red?

E) Are any other colors possible?

SEX-LINKED TRAITS

1. A man has a gene for a dominant trait on his X chromosome.

   a) Can he pass the gene to his daughters? If so, what proportion of his daughters will show the trait?

   b) Can he pass the gene to his sons?

   c) Does the man show the trait?

   d) Can his daughters pass the trait to *their* sons or daughters?

HEMOPHILIA

Hemophilia is a disease in which blood does not clot properly. Hemophilia is caused by a recessive gene carried on the X chromosome. Examine the following four marriages. Answer the questions that follow.

a) **Hemophiliac man** marries **Hemophiliac Female**

b) **Hemophiliac man** marries **Normal Female**

c) **Normal man** marries **Hemophiliac Female**

d) **Norman man** marries **Carrier Female**

1. Which marriage would produce the most hemophiliac children?

2. Which marriage would produce the most normal children?

3. Could couple c) produce normal boys?

4. Could couple c) produce hemophiliac daughters?

5. Why can't a man be a carrier?

ECOLOGY

THE WATER CYCLE

Answer these questions about the water cycle.

1. a) How do animals remove water from the water cycle?

   b) Why is water important for animals? List the body systems that use water to function.

   c) How do animals put water back into the water cycle?

2. a) Name one important way plants use water.

   b) How do plants put water back into the water cycle?

CYCLES IN THE ENVIRONMENT

1. Choose the correct answer.
   Why do plants need bacteria to change nitrogen to nitrate?
   A. Nitrogen is not available in the air
   B. Plants cannot use nitrogen in the air

2. In plants:
   What process gives off CO_2 ___________
   What process uses CO_2 ___________
   What process uses O_2 ___________
   What process gives off O_2 ___________

3. Name 2 things that plants provide to the environment. (Hint: Both are products of photosynthesis.)

4. Think about the nitrogen cycle, the water cycle, and the O_2 - CO_2 cycle.
   a) Why is it important that these systems are cycles?

   b) What would happen if they were one-way instead of a cycle?

   c) If the systems were one-way, what would be necessary to keep the ecosystem from dying?

   d) Is energy used in a cycle? If not, then how does life continue? Where does new energy come from?

ENERGY CHAIN

Rewrite the following things in the proper order for an energy chain.

Plants

Secondary consumers

Decomposers

Primary consumers

Sun Energy

---

1. Choose the organism that contains the greatest amount of original food energy.
    A. Primary consumer
    B. Secondary Consumer
    C. Producer

FOOD CHAINS

Arrange these animals into a food chain.

grass
cow
human

____

____

____

Now go back and match each of the following terms with one of the organisms.

producer
primary consumer
secondary consumer

Draw in the primary energy source for this system and draw an arrow to the organism that utilizes the energy.

FOOD WEBS

Arrange these organisms into a food web using the spaces below. Draw arrows from prey to predator.

wheat
grasshoppers
snakes
mice
hawks
lizards

____

__________ __________

__________ __________

____

1. What controls the size of the population of the top secondary consumer in a food web?

2. Did any consumer eat more than one item in the food web? Which one?

3. Was any organism eaten by more than one predator? Which organisms?

MATCHING

Match the words in the left column with the correct definition in the right column.

Ecosystem	A group of organisms of the same species that live together in an area
Population	The final state of succession in a community
Community	Major ecosystems with specific climate and organism populations
Environment	An area along with its biotic and abiotic parts
Biome	The climate and other abiotic factors in an area
Succession	The specific place an organism or species lives
Climax Community	The organisms in an area and how they affect each other
Habitat	The changes that take place in an ecosystem during its development

RELATIONSHIPS

1. Barnacles are small mollusks that attach to a surface in the ocean and then filter food from the water. Barnacles often attach to the sides of whales. The whales are not harmed by the barnacles. This kind of relationship is called ___________________.

2. A tick is a small animal that attaches to dogs (and other animals). The tick feeds on the dog's blood. The tick can cause disease and discomfort to the dog. This kind of relationship is called ____________________.

3. Cleaner wrasse are fish that live near large fish. The cleaner wrasse eat small parasites off the skin of the large fish. The cleaner wrasse get food and are protected by the large fish. This kind of relationship is called _______________.

4. Parasites harm their hosts. However, usually the parasite does not cause death in the host or causes death very slowly. How does this benefit the parasite?

5. Discuss the special reproductive needs of a parasite that lives inside another organism.

   a) Is reproduction likely to be sexual or asexual?

   b) If reproduction is sexual, are 1 or 2 organisms likely to be involved?

   c) Is it advantageous for the eggs to be ejected from the host? Why or why not?

POPULATIONS AND ECOSYSTEMS

1. a) Name at least three things organisms compete for in an ecosystem.

   b) Do members of the same population compete with each other?

   c) Do different populations compete with each other?

2. **You are the wildlife manager for a large lake. You want to increase the number of trout in the lake.**

   a) What could you add to the lake to increase the number of trout?

   b) What could you take out of the lake to increase the number of trout?

   c) Name some things that would limit how many trout you could raise.

CHANGING ECOSYSTEMS

1. You want to build a dam on a river to stop the water flow. You know that this will greatly change the ecosystem. You do a careful study to see how the change will affect the community.

   a) **Why is this important?**

   Your study reveals that the new dam will destroy the habitat of a small snail that lives in the river.

   b) **Is this important?**

   c) **How could this affect the rest of the ecosystem?**

   d) **What process allows species to survive in a changing environment?**

1. Turn to page 59 in the unit on bacteria. Read question 2.

   a) Is this graph relevant to populations other than bacteria?

   b) What is the resource that allows the beginning growth (the A part of the graph)?

   c) What are the limiting factors that cause the reduced growth rate of section B of the graph?

   d) What 2 limiting factors are causing the increased death rate of the population in section D of the graph?

2. There are two types of factors that affect the growth rate of a population. One type are called **Density Dependent Factors**. The second type are called **Density Independent Factors**. These "factors" are things in the environment that affect how many animals live, reproduce, grow, and die. **Can you guess what each of these labels (Density dependent and density independent) means?** (Use the dictionary to look up density if you don't know what it means.)

   Put the following factors under the proper category.

   food supply
   precipitation
   number of predators
   forest fire
   temperature
   quality of available water
   number of hiding places
   number of places to build a nest

Density Dependent Factors	Density Independent Factors

1. How could soil erosion on a hill above a lake affect the succession of the lake community? How would the erosion affect the succession of a land community?

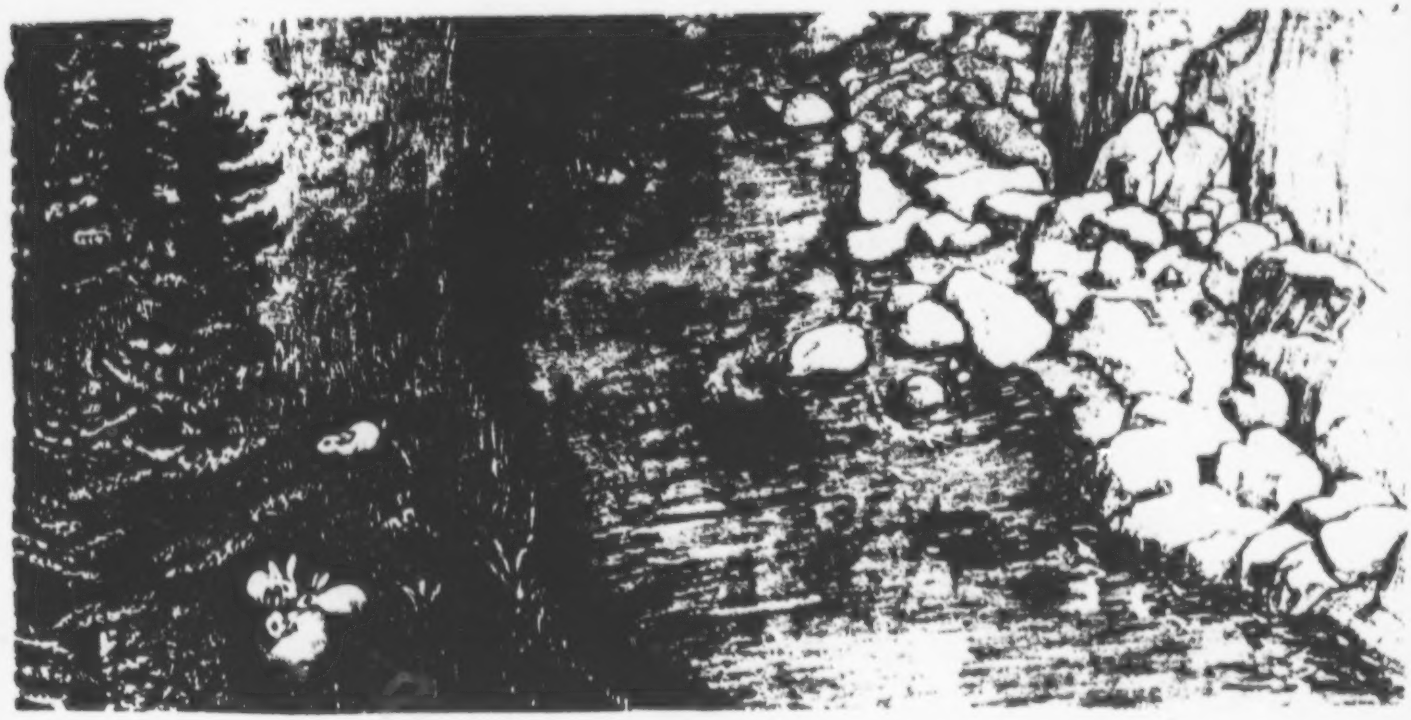
2. Which appears first in a new community, primary consumers, secondary consumers, or producers? Why?

3. **"The larger the animal, the more likely it is that humans can control or eliminate it."** Do you think this sentence is true? Why or why not?

4. a) Would adaptation and selection occur in a competition-free environment?

   b) Would variation occur?

WHERE DO ANIMALS LIVE?



In this ecosystem, a certain species of rabbit is only found on the left side of the river. You think this is because the rabbits cannot cross the river. **How could you test this hypothesis?**

In fact, you find that the rabbits can cross the river, but still no populations of rabbits are found living on the other side of the river. What else might be keeping the rabbits from colonizing the other side of the river?
Your partner has some information about the ecosystem. Ask your partner questions to get information about the ecosystem. Using the information, propose another hypothesis to explain the absence of rabbits from the other side of the river.

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